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PoeticAR: Reviving Traditional Poetry of the Heritage Site of Jichang Garden via Augmented Reality

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ABSTRACT

As a famed Chinese classical garden, the Jichang Garden was a constant inspiration to many poets in its hundreds of years' history, who composed a rich body of poems—a valuable intangible cultural heritage. While tourists tend to pay attention to tangible natural scenery and historical architectures, they often neglect intangible cultural heritage—poems. We interviewed 23 tourists and found that augmented reality (AR) was viable for tourists to enjoy the physical scenery and the poetry simultaneously. We developed an initial prototype of *PoeticAR*, which presents poems based on physical scenery to enhance tourists' cultural and aesthetic experience. We further revised the prototype based on the ideas generated from a workshop with 18 tourists. We conducted a between-subject user study with 30 tourists to compare *PoeticAR* with *Video*. Results showed that *PoeticAR* significantly motivated tourists' interest in poems, enhanced the cultural and aesthetic tour experience in Jichang Garden, and increased awareness of Intangible Cultural Heritage of Cultural Heritage sites.

1. Introduction

As tourist attractions of local, national, or global significance, cultural heritage(CH) sites provide tourists with contextual environments to experience and study relevant cultural, social, and political history. When sightseeing around the sites, visitors usually focus on tangible or visible buildings, cultural artifacts, and landscapes, while they neglect associated intangible cultural heritage(ICH) (Duxbury et al., 2016), such as traditional art, expression, and customs. ICH refers to non-physical assets that are inherited from the past generations of a community or society and recognized as part of local cultures (Unesco, 2003). ICH is critical for maintaining cultural diversity (Idris et al., 2016), facilitating local innovation, and promoting human societies' sustainable development (Duxbury et al., 2016). However, as modern urban lifestyles are quite different from traditional lifestyles based on which ICH has been created (Kuah & Liu, 2016), general visitors may find it difficult to notice, understand, and consume the ICH associated with the sites, and even have little interest in them. Introducing ICH to tourists and increasing their interest is necessary for better ICH protection and promotion. Otherwise, the ICH associated with heritage sites will fade away, and the cultural meaning will become almost inaccessible to visitors (Ahmad, 2006; Alivizatou, 2011).

Traditional methods for introducing the associated ICH to visitors include tour guides (McDonnell, 2001), audio guides (Gebbensleben et al., 2006), or public videos (Deuschl, 2006). They mainly provide visitors with a passive experience, which is detached from the physical space in which the visitors are immersed, and lack interaction for visitors to explore by themselves. In recent years, along with the rapid development and increasing accessibility, augmented reality (AR) has become an emerging solution adopted by CH sites (Bekele et al., 2018). By seamlessly superimposing the visual representation of ICH in corresponding physical places and allowing visitors to interact with the digital content, AR can give control to visitors and provide integrated experiences involving the intertwined ICH and its tangible counterparts (Bekele et al., 2018), such as interactive location-based AR storytelling (R. Azuma, 2015; Nóbrega et al., 2017) and gamification (Herbst et al., 2008; Wither et al., 2010). For example, prior works have developed location-based AR applications for historical scenes (Lang et al., 2019), nostalgic stories (Kromhout & Calvi, 2021), traditional handcrafts (Guo et al., 2020; Ji et al., 2019; Tan et al., 2020), and authoritative documents (Shin et al., 2017). Although these applications enhance visitors' experiences of and engagement with ICH of heritage sites, they primarily emphasize the reconstruction of

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previous environments, events, skills, and documents, while neglecting the artistic value of ICH.

Previous research on system beauty (Tuch et al., 2012) and hedonic quality (Hassenzahl et al., 2000) has found that involving artistic elements and enhancing users' aesthetic experience can improve the utility and initiative of innovative technology applications. However, no study has investigated how to engage visitors with ICH associated with a heritage site through AR applications so that visitors can experience both the artistic and aesthetic beauty of ICH and the beauty of the physical heritage site. In this paper, we aim to explore this topic by taking traditional Chinese poetry as a starting point.

As a representative ICH with high cultural and artistic value, Chinese poetry allows readers to feel and enjoy its beauty, as well as triggers readers' indirect aesthetic experience, emotional empathy, visceral expressions, and surreal imagination (Fernando et al., 2009; Jin, 1984; L. Li, 2004). However, among the numerous Chinese poems created in the past 3000 years, only a tiny part is familiar to ordinary people. The vast majority of poems are documented in classics, lose their vitality and face the danger of being forgotten and incomprehensible. Among the latter, many are composed by poets ontheir journey to depict historical sites, monuments, or other memorable places. They also have homology relationships with traditional Chinese paintings and landscapes, opening up the possibility of being transformed into vivid multimedia forms (Jin, 1984; L. Li, 2004). Thus, presenting the multimedia forms of poems in corresponding heritage sites with interactive AR may provide contemporary visitors without much poetry knowledge a deeper impression of the physical places and facilitate them to understand traditional poetry, thereby preserving the poems and ICH.

The design, usability, and utility of such AR applications have yet to be explored. For example, what kinds of interactions visitors prefer is unclear as well as how to transform poetry to multimedia forms effectively to meet their preferences given the nonlinear, abstract, and opaque characteristics of poetry. In this paper, we therefore seek to understand the following research questions:

RQ1: What are the visitors' needs and expectations for understanding and engaging with ICH, poetry in this paper, when they are sightseeing around a heritage site?

RQ2: How should an interactive AR application be designed to enhance tourists' site visit experiences and arouse their interest in ICH associated with the site?

RQ3: What are the design considerations to help visitors seamlessly experience physical scenes of a heritage site and its associated ICH based on the design and evaluation of our AR application?

To answer these questions, we chose Jichang Garden, a heritage site with 500 years of history. As a typical Chinese classic garden, it is popular and described in a rich body of traditional poems, making it a great starting point for us to explore AR approaches to revive ICH associated with a heritage site. We first conducted interview studies with 23 visitors in Jichange Garden to understand their site-visiting experiences, needs, and expectations. With these as a basis, we identified the opportunities to integrate poetry into their visiting experiences. Based on the findings, we built the first version of *PoeticAR*, an interactive AR prototype that aims to transform the associated traditional poetry into multimedia forms and blend the virtual multimedia contents with the physical landscape. *PoeticAR* not only offers visitors contexts to understand the poetry but also an interactive aesthetic experience. To further understand how visitors would interact with the prototype, we recruited 18 visitors to participate in a workshop. During the workshop, they played with the prototype as a design probe and expressed their ideas for improvement via sketches and interviews. The workshop feedback helped us further revise *PoeticAR*.

PoeticAR allows users to interactively learn knowledge about traditional Chinese poems within CH sites and enhance the cultural especially aesthetic experience in tourism, through a verse riddle game, multimedia presentation of poems, poem imagery interaction, poem words' annotation, poems' briefly background introduction, and other relevant poems exploration.

To understand whether and how *PoeticAR* enhances visitors' experiences, we conducted a between-subjects study with 30 visitors to Jichange Garden. Participants were asked to experience a video or an AR system presenting the same materials on mobile phones, and then completed 5-point Likert scale questions followed by in-depth interviews based on their answers.

Our results show that compared with the traditional video presentation, *poeticAR* helped participants understand the poems, improved their learning interest, and brought them an empathetic cultural aesthetic experience, which consequently improved their awareness of ICH. Finally, we present design considerations to facilitate the future design of AR applications for ICH associated with CH sites.

We make the following contributions in this work:

- Identification of the gap between tourists' expectations and actual experiences of ICH (i.e., poetry) associated with the heritage site (i.e., Jichang Garden).
- An interactive AR prototype, *PoeticAR*, which combines the multimedia presentation of traditional Chinese poetry and the physical landscape aesthetically through an iterative design with tourists.
- Design and methodological implications to enhance situated ICH experience by employing AR and design considerations for annotation, design, and technical exploration for ICH knowledge acquisition and emotional empathy derived from user studies.

2. Background and related work

To enhance the cultural and aesthetic experience within CH site visits through AR, we draw inspiration from prior literature in four areas: Chinese classical gardens and ICH, Poetry visualizing with multimedia, AR for ICH protection, and AR for CH tourism.

2.1. Chinese classical gardens and ICH

Chinese classical gardens are precious CH sites. They inspired not only classical oriental aesthetics but also contributed to global civilization. Traced back to Shang Dynasty 3,600 years ago, these gardens were initially constructed as sacred locations and then evolved into a physical embodiment of poetic dwelling ideology (Heidegger, 1971). Moreover, during the long-standing feudal age of China, Chinese classical gardens always acted as significant social occasions for ancient Chinese intellectuals, aristocrats, celebrities, and artists to unite and celebrate, who tended to write poems to record and express themselves under such circumstances (Keswick et al., 2003). Thus, Chinese classical gardens are frequent objects depicted by ancient Chinese, which gradually accumulated rich knowledge of ancient Chinese aesthetics, culture, history, philosophy, and literature (Jin, 1984; L. Li, 2004). To this day, they still represented the harmonious relationship between humans and nature, endorsed by traditional Chinese scholars (Cui & Hu, 2015). Moreover, the ancient Chinese poems associated with these gardens can even help tourists who lack knowledge of classical Chinese literature or history perceive the poetic Chinese lifestyle.

Among them, Jichang Garden is a typical one mentioned in hundreds of poems. During its 500 years of history, Jichang Garden experienced the vicissitude of rebuilding and fluxing. Currently, this garden is no longer the original one and is preserved by the local government as one of the places of interest for tourism. Except for the physical change, the poems related to Jichang Garden remained tactic. Hundreds of related traditional Chinese poems, describing the landscapes, visitors' thoughts, and activities within this garden, are preserved and presented in ethnographies, plaques, and tour guide pamphlets. However, most contemporary visitors pay little attention to such literary content, and some are even unaware of these poems' existence. This has motivated us to start by understanding the experiences and expectations of visitors to Jichang Garden and then explore ways to revive ICH based on feedback.

2.2. Poetry visualizing with multimedia

The abstract and connotative features of poetry and complex historical contexts make poems challenging to comprehend. Visualization with multimedia was considered to be an effective way to make poetry easily understandable (Tseng et al., 2009). Previous research has shown that visualized multimedia content (e.g., images, animations, words, and sounds) integrated into an interactive system represents an important means to help comprehension of poetry. For example, Yan et al. (2015) designed an animation synthesis system that can automatically generate animations of the poems based on the poem contents input to motivate the users' interest in poems by animation presentation. Given concise writing and rich connotations of poetry, Zhao and Ma (2020) provided users with a system for sketch-based animating images to visualize classical Chinese poetry by themselves. Visualization is effective to help the general public in figurative learning of poetry. Furthermore, previous research has suggested that users' learning performance and understanding extent can be observably improved by using context-based multimedia resources (Yang et al., 2013). For example, Weng et al. (2008) integrated scenic spots, poetry, and background music to enhance poetry appreciation. When users' are situated in an environment similar to what a poem describes, they can get a deep impression of the contents and enhance memories (Yang et al., 2013). These studies have directed us to realize the importance of situated visualization with multimedia. The potential drawback of the previous visualization system is primarily focused on poetry comprehension. It lacks consideration of emotional features and neglects the visual beauty of system content for aesthetic feeling. Besides efficient comprehension, as claimed in reference (Weng et al., 2008) presenting the emotional feature of poetry is a challenging issue. According to the theory of homology relationship between Chinese poetry and Chinese paintings (L. Li, 2004), poems and paintings can both present similar stories, emotional experiences, and artistic feelings. Our research attempts to visualize the poems with artistic multimedia contents in a context-based environment to arouse emotional experience and aesthetic feeling.

2.3. AR for ICH protection

ICH is essential in terms of cultural diversity and human creativity, which connects, communicates, identifies, and fulfills specific communities' spiritual needs (Unesco, 2003). As ICH is constituted by oral traditions, literal expressions, performing arts, festival events, rituals, conventional knowledge, and other similar human activities (Idris et al., 2016), ICH can not be easily touched and interacted with without the use of other means (Alivizatou-Barakou et al., 2017). Considering ICH is acknowledged as a byproduct of tangible cultural elements, AR applied to enhance ICH through overlapping the tangible cultural elements (e.g., cultural relics, handicrafts, and historical sites) is appropriate and effective to increase the ICH protection (Lang et al., 2019). Given the intangible or even invisible features of ICH, AR technology can help to make the invisible part of ICH visible with the strategy of embodiment (Moira & Makris, 2021). The embodiment of ICH with visualization and interaction in AR systems may enable users to easily utilize the cultural information of ICH (Ji et al., 2019), interactively engage in ICH learning (Tan et al., 2020), and design a compelling process of ICH experience (Herbst et al., 2008; Wither et al., 2010). These approaches make ICH understandable and appreciated through both informative presentation and entertaining enhancement. Furthermore, the strategy of embodiment also means that ICH experiences may be amplified through AR intertwining among individual, ICH, and tangible cultural elements (Moira & Makris, 2021). The intrinsic connection of them is essential for the communities' spiritual needs in ICH inheritance, which can be bridged through empathy (Kidd, 2019; Qiuru & Fan, 2020). Thus, we exert effort to find a comprehensive solution for

designing an interactive AR system to trigger intrinsic empathy in users for the awareness of ICH inheritance and protection.

2.4. AR for CH tourism

AR is helpful in enhancing the attraction of CH sites (Khanom et al., 2019; Masoud et al., 2019; Smuka & Reinane, 2018). In CH site tourism, historical or cultural knowledge is expected (Alkhafaji et al., 2020). Considering the dual requirements of enjoying ICH and exploring the physical environment of CH sites synchronously, AR is the first choice when combining physical environment and intangible virtual content (R. T. Azuma, 1997). Previous researchers concluded that "*The combination of real and virtual must be meaningful and powerful, where the core of the experience requires both the real and virtual components.*" (R. Azuma, 2015)

Previous research on CH site tourism with AR has primarily focused on representations of historical events and direct knowledge delivery. Researchers applied narrative and storytelling of CH sites with AR in the applications of animated historical war moments of Omaha Beach (Liestøl, 2018) and 72 personal lives transformed by World War II (Kromhout & Calvi, 2021) based on rich documentation. In addition, gamification was designed in AR to overlay interactive puzzles, mysteries, and riddles onto physical heritage sites, and directed visitors to figure out more hidden information spontaneously (Herbst et al., 2008; Nóbrega et al., 2017; Procyk & Neustaedter, 2014; Wither et al., 2010). There were also applications of a metadata schema for CH sites, which present multimedia databases(e.g., texts, videos, images) to improve the tourism experience (Shin et al., 2017).

However, most of these works neglected the cultural connotation and aesthetic value of ICH (e.g., poetry, music, and folk customs) related to CH sites during tourism. These works also missed system beauty (Tractinsky et al., 2000; Tuch et al., 2012), which is an important perspective discussed and emphasized by HCI researchers since 2000. Actually, the hedonic and aesthetic quality of technology (Hassenzahl et al., 2000) has always been a significant dimension, which is believed to enhance users' aesthetic experience and finally improve the scale of utility, initiative, and enjoyment of innovative technology applications (Cyr et al., 2006; Y.-M. Li & Yeh, 2010). Therefore, we want to highlight the aesthetic aspect of CH sites and relevant ICH through AR, to enhance visitors' novel perception and engagement with CH sites.

3. Formative study

To answer our research questions, we first conducted an onsite in-depth interview for exploring the attitude and requirements of visitors towards the poetry during the tour of Jichang Garden. We then designed a prototype base on the finding and conducted a workshop with the prototype to further understand the details of the requirements, obtain insights from tourists, and gather user feedback on the prototype for iteration.

3.1. Pre-investigation

3.1.1. On-site investigation among the visitors

To better understand our target users, we investigated the tourists' *attention*, *interest*, *understanding*, and *aesthetic appreciation* towards the poems about Jichang Garden as well as their *satisfaction* with the existing carrier of poems and *attitude* to AR as an experienced tool in tourism. We randomly recruited 23 visitors and conducted about 20 to 30 minutes of semi-structured interviews inside the Jichang Garden.

3.1.2. Demographics

Among 23 interviewees (V1–V23), 17 were females and 6 were males; 2 were under 18, 10 were between 18 and 26, 10 were between 27 and 45, and 1 was above 45; 4 were local, and 19 were out-of-town travelers. Among them, five often visited the Jichang Garden, and the others visited the first time or very few times. Six visited alone and the others visited with family or friends.

3.1.3. Findings

3.1.3.1. Attitude towards poetry of Jichang Garden. To obtain visitors' attitudes, we first asked about their concerns about the poetry of Jichang Garden and its history and cultural background. We then showed them a book, *Voluminous Chorography of Jichang Garden* (Qin, 2009). We randomly selected one poem from the book for the interviewees to read. The result indicated that most of the interviewees ($N = 18$) did not know the book and understand the poems very much. As V18 noted, "*It is not so popular, so I haven't heard about it*". Although the book includes hundreds of related poems, it is elusive and unattractive to the public. The interviewees mentioned that they had insufficient knowledge of the history of poems, did not understand some rarely-used words in poems, did not have much time to study during the tour, and did not want to conduct professional research on poetry. However, they also felt regret about this and expected to know more. "*I try to understand, but not deeply*" (V9), "*I prefer to read poems with relevant history and cultural background knowledge.*" (V7) and "*I feel regretful for being unable to appreciate all the meaning of poems relevant to the scenic spot HeBuTan*" (V20). The curiosity of new knowledge of Jichang Garden would motivate them to explore more about poetry and its history and cultural background. Furthermore, the interviewees mentioned that they needed to make use of imagination to grasp the image depicted in the poem and be attracted by poetic artistic conception. Nonetheless, V19 said "*I can't fully understand the feelings of ancient poets without some help.*" The physical scenario would help to build empathy between ancient poets and the readers. As V18 said "*It makes me closer to the ancient poet by reading the poem inside the pavilion of the garden where the poet wrote the poem.*"

3.1.3.2. Satisfaction with existing carriers of poetry. We asked the interviewees' attention to the poems on the plaques, pamphlets, and billboards in the Jichang Garden during the tour, and how they used digital applications or electronic devices (e.g., audio guides, search engines, and tour apps) to acquire knowledge of Jichang Garden. Many of them ($N = 12$) felt unsatisfied with the existing presentation of poetry (e.g., plaque, pamphlet, and billboard). They reported that the existing poems in the garden were not easy to understand without explanation. In addition, tourists lacked the motivation to consult supplementary resources for understanding poems, partly because they could not recognize the writings. As V18 reported, "*I don't understand because it is difficult for me to recognize the calligraphy font.*" Another reason was the carriers of poetry (e.g., plaque and electronic screen) were unattractive to tourists. For example, our interviewees complained that electronic guide devices offered general introduction without cultural value, or merely provided voice without interaction. Moreover, they did not approve of learning or understanding poetry through the search engine or tour apps during the tour. As V21 said, "*The process of searching for poems is too complicated and time-consuming in a tour, and it is difficult to find the answer I want.*" Tour apps mainly provide tourism services (e.g., ticket booking, brief introduction, and tour maps) and other tourists' comments sharing. The cultural information provided by tourism apps or electronic guides was neither sufficient nor intuitive from tourists' perspectives. As V22 reported "*I think the information on the Internet is insufficient, and I still cannot understand with such help.*" Rather than tour apps or electronic guiders, the interviewees with their kids suggested that "*It would be better if there were some richer contents and forms for my kids to learn during the tour.*"

3.1.3.3. Familiar with AR in tourism. We asked about the interviewees' previous experience in AR and their attitude towards applying AR in tourism. We found that 40% of the interviewees were very familiar with AR such as the application of AR in emoji making or video effect making in popular apps (e.g., WeChat and TikTok), and 80% of them had experienced AR applications once or twice. Many interviewees ($N = 12$) agreed that AR might improve their tour experiences in many aspects, such as interactive experiences, interesting games, offering relevant knowledge, and additional tour items. The interviewees said that "*Interactive approaches helped me understand the historical background during my previous tour experience*" (V17) and "*Games were approaches to engage mutual emotional communication.*" (V10). However, the intervie wees also mentioned their concern about the impact of AR or other interactive digital facilities on their tour experience of the landscape. Moreover, duration was a big concern reported by the interviewees. As V23 said, "*AR should be very interesting, but not everyone will be willing to use it because the scenic area is huge but the schedule is tight. Generally, visitors like me only take one-day trips.*" Additionally, the interviewees visiting alone mentioned that they would not like to interact with strangers through AR. The interviewees visiting with their companions said "*we approved of AR interactive or AR games as we could play together*" (V7).

3.1.4. Discussion

Through onsite garden interviews with tourists, we found that the dissatisfactory interaction between tourists and ICH (e.g., poetry, history, and culture) was primarily due to the lack of effective communication media to bridge the gap between the requirement and curiosity of knowledge and the difficulty of understanding. Although the physical scenario helps construct the tourists' feeling of ICH, there are still few productive ways for ICH access in the Jichang Garden. Tourists were interested in understanding and interacting with ICH in CH sites through AR technology or AR game. However, physical tour experiences such as scenery sightseeing, companion communication, and physical relaxation were primary concerns during the tour.

3.1.4.1. Requirements of tourists. We derived a set of requirements from the preinvestigation for providing an engaging cultural and aesthetic experience and ICH knowledge for tourists. First, tourists had a curiosity to know the relevant poetry of CH sites during the tour but were not very professional. Second, tourists expected to understand the poems in easy, attractive, and interesting forms. Third, tourists need the embodiment of the poems in physical scenarios to build empathy.

3.2. Design decisions and prototype

According to the preliminary interviews, AR has the potential to engage tourists to experience scenic beauty while enjoying scenery-associated poems. Thus, we devised our initial AR prototype to present the poems overlapping the landscape and used it as a design probe to gain further feedback. Due to the tourists' concerns about the impact of ICH learning on their physical relaxation during the tour, our AR prototype will be for use inside specific scenic spots and not for the whole tour process. By comparing tourists' traffic and occupied area, we chose the *ZhiYuJian* as our test bed because it is one of the most significant scenic spots in the Jichang Garden, and its space is ample enough for visitors to experience AR. Due to the expectation of tourists on poetry during tours, the AR system presents poems in multimedia forms with supplementary knowledge such as poems' words annotations and background information for attraction and understanding. Besides, considering the tourists' interest in novel interactive experiences and preferences for games during the tour, we decided to add a game to arouse curiosity about the poetry of Jichang Garden in the AR system and to provoke the tourists' understanding and empathy of poems. Thus, our initial prototype design integrated game, knowledge, and multimedia for situated poetry access.

Figure 1. Initial prototype. (A) Step1: Play the verse riddle game. (B) Step2: Read the poem inside scenery. (C) Step3: Enjoy the poem presented in multimedia form.

3.2.1. Prototype design

According to the three primary requirements of the tourists, we set three steps in the prototype for tourists to experience the poems within scenic spots via AR. The three steps interaction workflow of the AR prototype led the tourists progressively by arousing curiosity, helping to understand, and enhancing cultural and aesthetic experience (Figure 2). The first step is to "**play the verse riddle game**" (Figure 1(A)) for arousing curiosity and provoking the tourists' connection between scenery, the name of the scenic spot, and poems. We borrowed a traditional game form that is still popular at present and used lanterns as a verse carrier because it is a conventional element of this scenic spot in ancient times and remains used as decorations in Chinese traditional gardens. According to the space of the scenic spot for navigation in AR, we set three lanterns in the prototype. Tourists will navigate inside the scenic spot to find lanterns (Figure 2(B)), then guess the verse according to the corresponding location by touching the verse hanging on the lanterns through finger gestures (Figure 2(C)). When the correct answer is chosen, the second step will be triggered. The second step is to "**read the poem inside scenery**" (Figure 1(B)) for helping the tourists understand the poem with words' annotations and background information. During this step, the poem on plaques (Figure 2(D)) with some related supplementary contents such as poem words' annotations, author name, background knowledge, etc. (Figure 2(E)) will be revealed in front of the screen. Users can walk to zoom in and out of the AR content for reading. In the last step, tourists can "**enjoy the poem presented with multimedia form**" (Figure 1(C)) within the physical scenery for cultural and aesthetic experience enhancement to arouse the empathy between tourists and ancient poets (Figure 2(F)).

3.3. Workshop

To gather tourists' feedback about the initial prototype, observe tourists' integration with AR, learn more details of tourists' needs for poem understanding, obtain insights from tourists' imagination of poems presentation, and understand the tourists' thoughts on the connection between the poem and its associated scenic spot, we conducted a workshop with follow-up semi-structured interview inside the scenic spot *ZhiYuJian*.

3.3.1. Procedure

We first provided the following three questions printed on paper to survey the poem's understanding: *Q1:* Guessing which verses are related to the scenic spot *ZhiYuJian*. *Q2:* Writing the meaning of the poem without and with poem words' annotations. *Q3:* Ranking the 9 background information by the importance for the understanding of the poem.

We then asked participants to select fonts for text presentation and brainstorm aesthetic imagination of poems' visual representation by drawing and collaging according to the description of poems (Figure 4). Next, the participants experienced the prelim-inary prototype inside *ZhiYuJian* following the designed three steps: game playing, poem reading, and visualized poem enjoying (Figure 2). Figure 3 shows how workshop participants engaged in different activities.

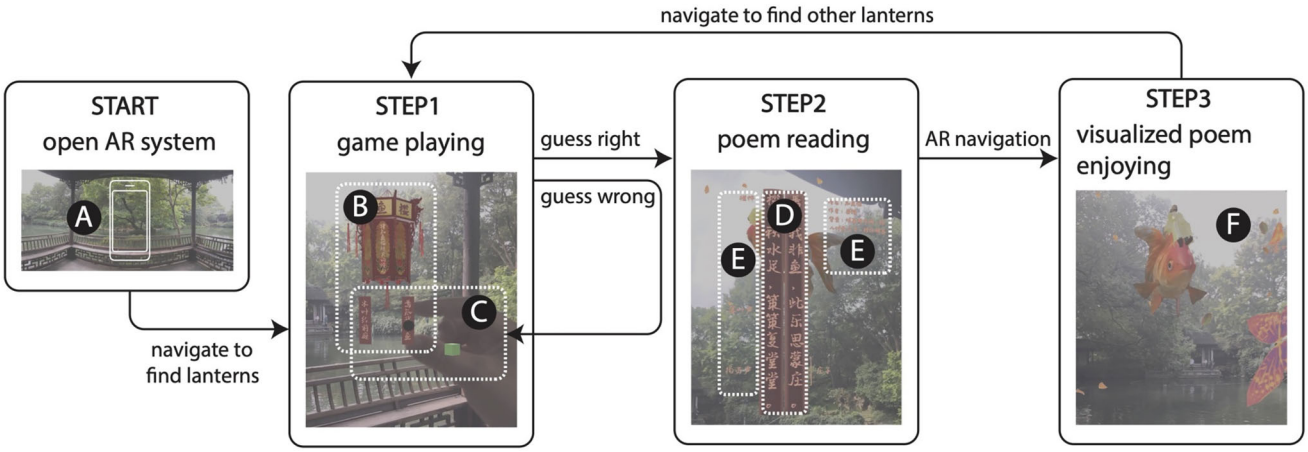

Figure 2. Workflow of the initial prototype. (A) Open the AR system inside the scenic spot on the mobile phone. (B) Navigate to find lanterns for game playing. (C) Guess the verse related to the scenic spot with a finger gesture. (D) Read the poem associated with the scenic spot. (E) Read supplementary knowledge of the poem. (F) Enjoy the visualization of the poem's imagery and depiction overlapping the physical scenery.

Figure 3. Participants in the workshop. (A) Writing the meaning of a poem. (B) Drawing an image based on the poem. (C) Making poem imagery collage. (D) Using prototype in the scenic spot.

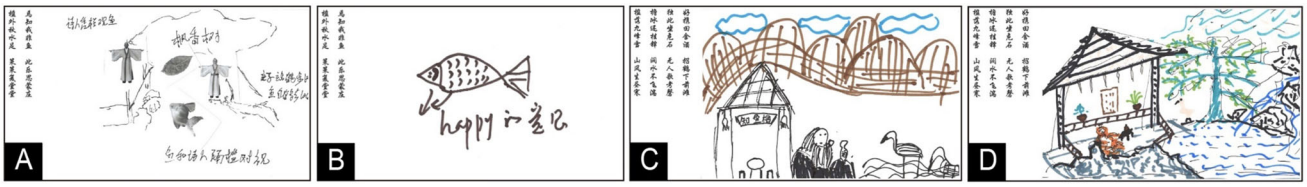

Figure 4. Illustrated graphs according to poems by participants. (A) The Poet and the fish are Looking at each other. (B) Fish with a smiling face expressing happy emotion. (C) The scenery described in the poem is illustrated beyond reality. (D) The poem is illustrated based on the physical scenery.

Finally, we conducted a 30-minute follow-up interview based on the workshop output and their prototype experiences.

3.3.2. Demographics

We randomly recruited 18 tourists (E1-E18; none of them participated in the formative study) in the Jichang Garden and divided them into 7 groups to participate in workshops. There were 7 males and 11 females; 2 were under 18, 3 were between 18 and 26, 10 were between 27 and 45, and 3 were above 45. Among them, eight often visited the Jichang Garden.

3.3.3. Poem understanding on site

3.3.3.1. Verse riddle judgments for game design. We randomly selected two poems related to the *ZhiYuJian*. We paired four verses of each poem with alternative randomly selected verses to form a puzzle. According to the readability, legibility, and relevance with location, the puzzle varied in two difficulty levels. For the simple part, 76.4% of the participants answered correctly, whereas the accuracy of the difficult part was 41.2%. We found that participants usually estimated whether the verse was related to the place based on *whether the words in the verse have the corresponding place name*, *whether the descriptive or words in the verse have the relevant scenery elements*, or *whether the meaning and artistic conception of the verse similar to the scenic spot*. In addition, the problem of word's readability and legibility will surge the puzzle's difficulty. For a small number of tourists ($N = 3$), they made judgments based on intuition. Tow had already known the verses. The finding offers the strategy to design the verse riddle game.

3.3.3.2. Knowledge acquisition. We compared the poem understanding with and without poem words' annotations and background information. The results indicated that the words' annotations and background information were beneficial for participants to notice more details of the poems

and deeply feel the poet's emotions. However, the participants were more imaginative in understanding without accurately knowing the poem's meaning. To further determine the influence of different information on participants' understanding abilities, we asked participants to rank nine regular information. The resources included the poem title, the poet's name, the poet's biography, the dynasty, the historical background, the words' annotations, the explanation of metaphors, the emotion, and the theme. We found that participants viewed the poem title, the poet's name, the dynasty, and the historical background as significant.

3.3.4. Poem presentation in AR

The two ways to present the poems in AR are to present the poems' texts directly and to present poems with visual or multimedia forms. Both are important for poem appreciation and enjoyment. Thus, we researched font style and visual beauty for aesthetically presenting poems.

3.3.4.1. Fonts of texts for poem presentation. We considered readability, artistic form, and regional cultural traits of fonts. We provided participants with three representative fonts choices of *A, boldface script; B, Xingkai script;* and *C, cursive script*. Option A shows few regional cultural traits but is easy to read among them. On the contrary, the other two take traditional Chinese calligraphy font styles. Option C is the hardest to read but probably the most artistic. According to our participants' feedback, option A was dismissed, with a 0% selection rate. Options B and option C tied in popularity. Specifically, 47% of the participants chose B for its relatively easy-to-read characteristics, and 53% chose C for its unique *sense of age*. We concluded the font design requirements as traditional styles and artistic forms consistent with the garden environment. The readability is not a priority but should also be considered. Therefore, the font style choices should be between B or C.

3.3.4.2. Visual beauty of poems. Participants provided many suggestions for the artistic visual presentation of the poems in AR. The poem visualization of the initial prototype received comments, such as "*It's too monotonous now*" (E2), "*Don't use too much color*" (E3), "*Image should be exquisite*"(E7), and "*Artistic conception should be elegant*" (E7). Participants' hand-painted graphs highlighted the imagery of their imagination of poems (Figure 4). The surreal and the reality constructed the visual presentation of poems in their minds. Their drawings reminded us to try personification strategies when presenting animals or plants to build interaction between the imagery of poems and the tourists. Additionally, E14 said "*I have my imagination of poems, I will feel aesthetic enjoyment if the visual contents would be more beautiful beyond my imagination.*

3.3.5. Experience of AR

3.3.5.1. AR overlapping scenery in scenic spots. We found that AR was an effective instrument and novel form for poems presented in relevant scenic spots, but the impact of AR was also a concern for tourists. Our participants took notice of the conflict between new digital technology and traditional heritage site. As E17 said, "*The garden is old style. Overlapping AR content on scenery makes the sense of technology too strong. You will feel too abrupt or should not belong here.*" Moreover, they proposed a concern of harmonious combination of the virtual and the physical in AR. E1 complained that "*The AR system was not integrated well into the landscape now.*" Specifically, E10 illustrated the importance of proper image scales in AR, "*the proportion of virtual contents are too large to cover physical scenery.*" Besides the harmonious visual style, participants also mentioned the movement of imagery made the virtual contents vivid for blending into the still physical scenery.

3.3.5.2. AR interaction for engagement. By observing participants' interactions with the verses riddle game, we found that the setting of touching virtual lanterns with fingers was inappropriate. In particular, the initial interaction design did not meet our participants' expectations, and they reported difficulties in conducting the squeeze gesture. For example, E6 suggested that the AR system should be "*more direct and intuitive.*" In general, they preferred directly touching the screen without extra movements. Moreover, our participants suggested improving engagement. For example, E16 said that "*it could add a little interaction for interest in AR, but not too much.*" Besides, most of the participants ($N = 13$) didn't actively navigate in AR at the beginning. Still, they appeared enjoyable after we gave them a tip that they could navigate physically to experience and explore the content in AR.

3.4. Summary of the formative study

We got many insights from the formative study. Accordingly, we incorporated insights into the prototype to design our AR system *PoeticAR*.

3.4.1. Design insights

The judgment criteria of tourists provide the method for the further design of the difficulty levers of the verse riddle game. The workshop indicated that the verse riddles enhance the awareness of the relationship between the poem and the scenery. The scenic spot name, physical scenery elements, poem words' annotations, and key background information were helpful for tourists to understand the relevant poems. Both the texts and multimedia forms of poems should be presented in AR with aesthetic expressions, such as traditional cultural style, visual beauty, harmonious combination, and vivid movement. The novel interactive behavior in the prototype, such as finger gestures, is unnecessary, while participants expected simple and interesting interaction. Participants also expressed a need to access more related poems if they were interested in poems related to a scenic spot. The participants who had already known some poems expected more poems for extended reading.

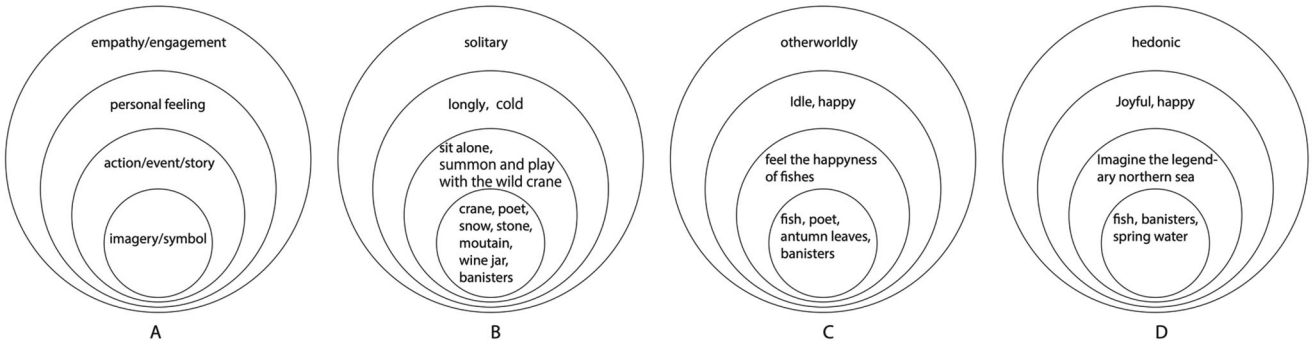

Figure 5. Poem annotation methods: (A) Annotation methods of four aspects. (B) Annotation of poem *Seeing snow in ZhiYuJian*. (C) Annotation of poem *Twenty poems of Ode to JiChang Garden-ZhiYuJian*. (D) Annotation of poem *Ten poems of Ode to JiChang Garden-ZhiYuJian*.

Moreover, E13 mentioned "*it is better to have sounds. Poem reading might help me understand the poem better.*"

3.4.2. Prototype iteration

We designed and implemented *PoeticAR* based on the iteration and optimization of our AR prototype. The following improvement was carried out: (1) Optimize the verse riddle game by balancing the puzzle's difficulty and changing the interactive approach. (2) Choose text font by trading off the readability and traditional stylization. (3) Refine multimedia content, including image tone, figure details, visual design, and animation smoothness. (4) Improve the coherence of physical and virtual contents by color adjustment. (5) Simplify the system interaction by reducing interactive steps in the system and adding optional functions for the various requirements of tourists, such as knowledge extension and interaction for fun. (6) Add sounds to the AR system.

4. PoeticAR

4.1. Design concept

Our design goal was to explore effective design methods, allowing tourists to experience the poetry of CH sites during the tour. We intended to provide both physical and cultural experiences simultaneously with the aesthetic expression of poetry presented via AR, to enhance tourism to CH sites by providing easy access to ICH, to motivate tourists' interest in the cultural connotations of CH sites, and to provoke awareness of ICH associated with the CH site.

4.2. Poem annotation for multimedia presentation

Considering *homology theory* (L. Li, 2004) stating that visualizing poems with images and animation can significantly help people understand their connotations, we took Chinese poetic imagery as a crucial design resource for *PoeticAR*.

Chinese poetry has an imagery data set. The imagery usually refers to physical objects (e.g., animals, plants, and architecture) with hidden meanings. Their functions are to indirectly embody the poet's imagination, emotions, expectations, knowledge, or suggestions. The use of imagery is the key to understanding the themes of poems (L. Li, 2004).

However, differences exist between literature and poetry theories of various cultural backgrounds. To solve this problem, we looked into the linguistic domain for inspiration. Through discussions, we applied the *semiotics theory* from an influential linguistic scholar Ferdinand de Saussure (Eco, 1979), and we established annotation methods based on it. The core components of *semiotics theory* are the *signified* and the *signifier* (Chandler, 2007), which constitute a comprehensive system to illustrate how language and meanings are associated with each other. Semiotics theory coincides with traditional Chinese composition rules. In other words, the imagery words act as the *signifiers* or symbols, which encode the poets' emotions, imaginations, or suggestions. Accordingly, we constructed a set of data annotation methods for four aspects: imagery/symbol, related event/story, authors' personal feelings, and empathy/engagement (Figure 5(A)). We then annotated the three poems used in our AR system (Figure 5(B–D)). The method is not only applicable to Chinese poetry but also for other poems sharing similar characteristics of euphemism and homology.

4.3. User scenario and AR system design

Based on the prototype, *PoeticAR* was also designed for relevant poems presentation in the *ZhiYuJian*. We randomly chose three poems describing the scenic spot *ZhiYuJian* and annotated the poems (Figure 5(B–D)) for presentation in *PoeticAR*. To avoid impacting the whole physical tour experience, optimize the interaction process, and make the poems accessible as easily as possible, we revised three hierarchical steps in the prototype to two hierarchical steps with two functions embedded in step 2 based on formative study insights. The first step is *verse riddle game* (Figure 6(A)). The second step is *poem presentation* (Figure 6(B)). To balance the various requirements of tourists from our formative study, the two extra functions are designed for users' choice: one is *poems' imagery interactive function* (Figure 6(C)) and the other is *poem annotation and exploration function* (Figure 6(D)).

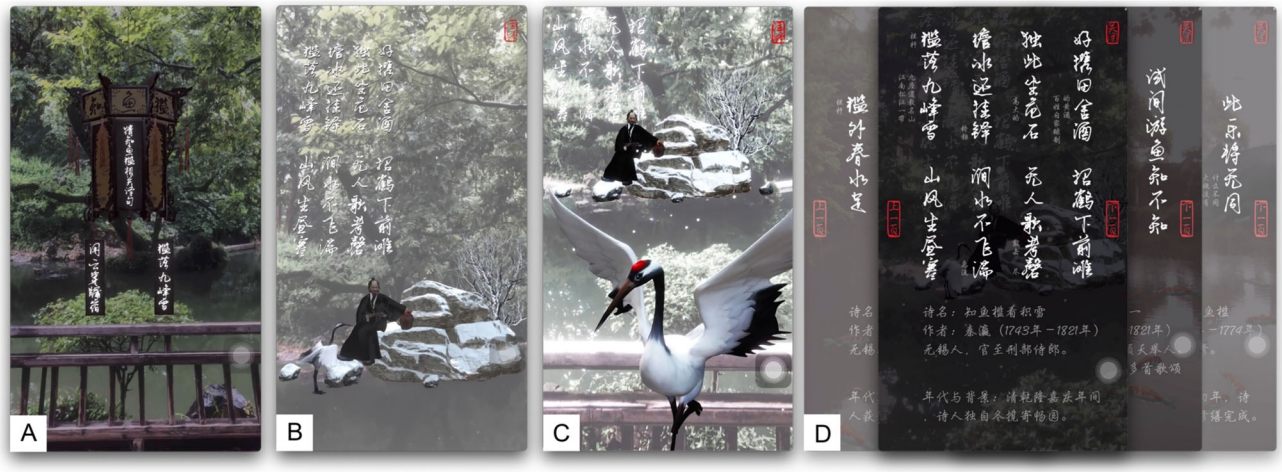

Figure 6. PoeticAR system: (A) Step1: Verses riddle game. (B) Step2: Poems presentation. (C) Step2-function1: Poems' imagery interaction. (D) Step2-function2: Poems annotation and exploration.

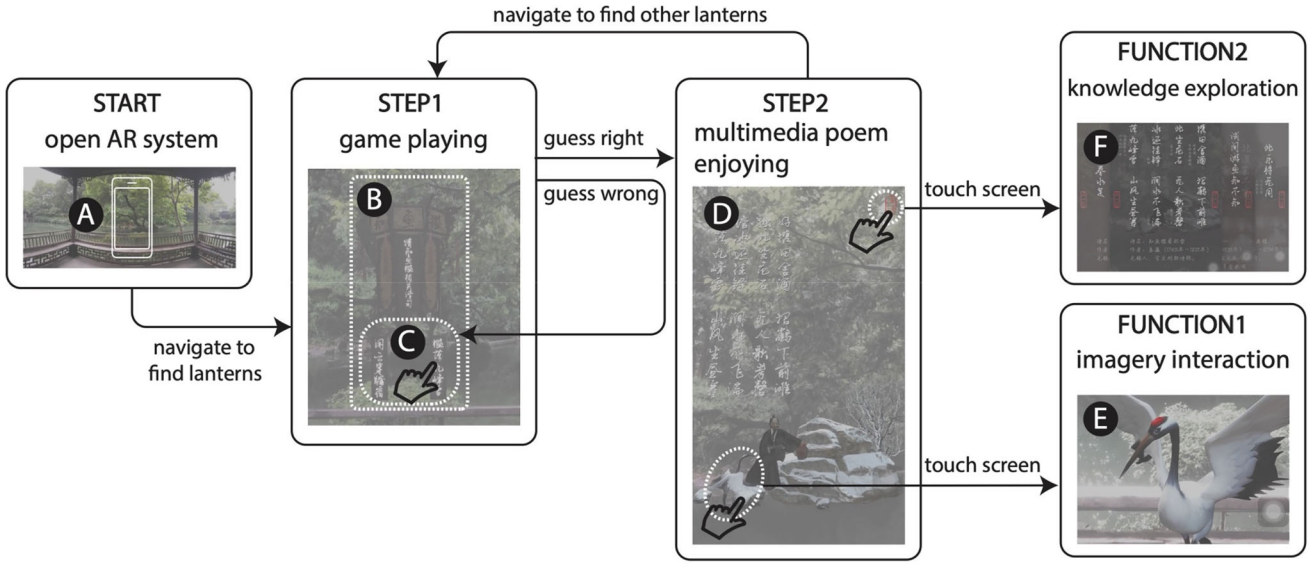

Figure 7. Workflow of PoeticAR system: (A) Open AR system inside the scenic spot on the mobile phone. (B) Navigate to find lanterns for game playing. (C) Guess the verse related to the scenic spot. (D) Enjoy the presentation of the poem's imagery and depiction overlapping the physical scenery. (E) Interact with poems' imagery. (F) Explore the supplementary knowledge of the poem and other related poems of the scenic spot.

4.3.1. Verse riddle game design

According to the finding in the formative study, we paired four verses of each poem we selected with alternative randomly selected verses to form two easy puzzles and two hard puzzles for each poem's verse riddle. The aim is to provoke the tourists' thoughts but not to discourage them. The game begins with the display of three AR lanterns, and each lantern carries one poem's verse riddle. Tourists need to navigate in the scenic spot to find a lantern in the AR system to play the game (Figure 7(B)). A short voice prompt will automatically be aloud for the tourists' convenience to make a tip on the approach of the game playing when the tourist is near one lantern. One of the four puzzles of a poem will randomly appear on the lantern. Tourists choose with fingers clicking on their selected verse on the lantern (Figure 7(C)). If tourists guess correctly, the lantern will vanish. Then, they would be allowed to see the multimedia display of the poem guessed previously in the second step (Figure 7(D)). If not, they have to guess the next puzzle. If all four puzzles are incorrect, the game will start over again. So, tourists can easily pass in the second round. Additionally, tourists can skip to other lanterns illuminated within the AR space at any time. The process of the game is the same.

4.3.2. Poem presentation design

To simplify the interaction steps, we combined and optimized the content of step 2 (Figure 1(B)) and step 3 (Figure 1(C)) of the prototype in this step, though providing more optional functions for the requirement of tourists. Poems presented in *PoeticAR* allow tourists to appreciate the multimedia forms of poems superimposing the scenery through AR (Figure 7(D)). Besides, it will enable them to explore

more relevant poems and knowledge for extended reading (Figure 7(F)) or do poem-related interesting interactions (Figure 7(E)) optionally.

In this step, tourists can enjoy virtual calligraphy art pieces of a poem with a voice reading to help their understanding and simultaneously experience the multimedia presentation of the poems' imagery (e.g., fish, birds, butterflies, cranes, and fallen leaves) with sound effects to enhance the emotional feeling. Because the poems' imagery depicts and revives the poetic, artistic, and emotional scenes felt by ancient poets. For example, cranes are viewed as auspicious omens, and butterflies in traditional Chinese philosophies represent rebirth and freedom. Additionally, tourists can hear light music played by traditional Chinese instruments (e.g., Guqin and Zheng) throughout the process to enhance aesthetic enjoyment. Furthermore, we adjusted the visual color setting in *PoeticAR* to increase the harmony of the real-time rendered virtual elements overlapping the physical scenery and perfect the visual beauty of the presentation. The 3D virtual contents are rendered with real-time environment lighting according to the physical view. AR system will change the color of the scenery presented in the background according to different poems' contents.

4.3.2.1. Poems' imagery interactive function design. To solve the issue raised in the workshop that the coverage of the virtual content impacts scenery appreciation in AR, the virtual imagery of poems is at a distance in the AR system by default. The setting keeps the proportion between virtual contents and physical contents balanced. Tourists can let the virtual imagery such as cranes, fishes, and butterflies approach or depart by touching them on the screen to watch them nearly. These animals will approach the font of the screen with attractive animation. This design also provides interesting and funny interactions in the system. For example, From Figure 7(D) to Figure 7(E) shows that interaction with a virtual crane allows tourists to follow the behavior of poets to summon and play with wild cranes discredited in the poem.

4.3.2.2. Poem annotation and exploration function design. If tourists want to know more a bit professionally, they can click on the notes button on the screen (Figure 7(D)). With this function (Figure 7(F)), tourists take their time and learn the detailed annotations of deep phrases expressed by the ancient Chinese language (e.g., classical mimetic words and ancient names of animals and plants) and supplementary literature knowledge (e.g., the writing background, authors' name, and introduction). If the tourists are interested in exploring ancient Chinese literature, the AR system also provides more poems depicted in the same scenic spots with poems' supplementary literature knowledge.

5. User study

The study was carried out at the scenic spot *ZhiYuJian* within Jichang Garden. We conducted a between-subject user study to compare *PoeticAR*[1] with the *Video*[2]. We chose video format as a baseline because video is a popular format through which the public consumes multimedia information. Tourists usually watch videos on tour apps or short-video apps to obtain related information when visiting physical heritage sites. We prepared the *Video* by sequentially recording all the multimedia contents from *PoeticAR*. Tourists experienced *PoeticAR* and the *Video* in our provided mobile phone inside the same scenic spot *ZhiYuJian*. Their difference was that the multimedia contents experience in *PoeticAR* overlaps the physical scenery, whereas the *Video* does not present physical scenery images. Besides, the process of experiencing the multimedia contents in *PoeticAR* was interactively following two designed steps, whereas the *Video* sequentially plays the same multimedia contents without interaction. Nevertheless, we allowed the participants to pause the video to engage in the verse riddle game, appreciate poems, and read supplementary information.

5.1. Demographics of participants

We recruited 30 tourists in Jichang Garden to participate in our user study. There were 13 males and 17 females; 9 were under 18, 2 were between 18 and 26, 11 were between 27 and 45, and 8 were above 45; the average age was 33.86 (SD = 14.9). Among them, twenty participants often visited Jichang Garden. Fifteen visited the Jichang Garden together. Their relationships were parents and children ($N=7$), couples ($N=4$), and companions ($N=4$). All participants were paid 55 yuan for their participation.

5.2. Study design and procedure

The 30 participants were randomly separated into two groups, namely 15 participants for *PoeticAR* (P1–P15) and 15 participants for the *Video* (P16-P30). All studies lasted 20–30 minutes.

Initially, we generally introduced our research topic, which was about Jichang Garden and its traditional poems. Then, we provided the same mobile phone to the participants to experience *PoeticAR* or the *Video*. Afterward, we asked the participants to complete a 5-point Likert scale questionnaire based on previous experience items. To design our questionnaire, we refer to the research on AR applied in Korean Changdeokgung Palace (Shin et al., 2017), because the Palace has many similarities with the Garden, e.g., rich cultural contents and scenic beauty with oriental buildings and gardens. However, compared to the research, we designed our current AR system without the location-based feature but for the specific location application. Thus, according to the questions, the issues, and the insights in our formative study, we were in light of four aspects to design our questionnaire to evaluate our AR system's effectiveness: (1) Engagement such as attraction and usability (i.e., Q2, Q6), (2) Engrossment such as emotions and curiosity (i.e., Q3, Q8), (3) Immersion with cultural and aesthetic experience (i.e., Q4, Q5, Q9), (4) An acquaintance of ICH (i.e., Q1, Q7). Finally, we conducted a semi-structured interview based on each question in the questionnaire. We aimed

to know more details about individual experience feedback and better understand their experiences with *PoeticAR* and the *Video*. We surveyed the participants' reasons behind their choices and attitudes towards experiencing ICH (e.g., poems) in CH sites through different methods (i.e., AR/video).

6. Results

6.1. Quantitative results

We asked participants to rate the following questions after using *PoeticAR* or watching the *Video* on a 5-point Likert scale of 1–5 (1: strongly disagree, 5: strongly agree): *Q1: I felt ICH was valuable to the garden. Q2: the interaction and content were attractive. Q3: Lantern riddles provoked me to think about the connections between the poems and the scene. Q4: Showing scene-related poems helped me understand the poems. Q5: Showing scene-related poems helped me enjoy the physical scene. Q6: Showing poems prevented me from enjoying the physical scene. Q7: Seeing annotations of the poems helped me understand the poems. Q8: I was more willing to learn poems related to the garden. Q9: My tour experience was enriched with added cultural elements (i.e., poems).*

Figure 8 shows the distributions of the participant's ratings of the questions regarding their experiences of using *PoeticAR* and watching the *Video*. Mann-Whitney test results found the significant or marginally significant differences[3] for the follow-ing questions: 1) Q7 ($z = -2.49$, $p = 0.01$): Participants felt that the annotations of the poems provided by *PoeticAR* ($Md = 5$, $IQR = 1$) **helped them understand the poems** significantly more than the *Video* ($Md = 4$, $IQR = 0$). 2) Q8 ($z = -1.68$, $p = 0.09$): Participants were marginally more **willing to learn the poems about the garden** after using *PoeticAR* ($Md = 5$, $IQR = 1$) than watching the *Video* ($Md = 4$, $IQR = 0.5$). 3) Q9 ($z = -1.96$, $p = 0.05$): Participants felt *PoeticAR* ($Md = 5$, $IQR = 0$) **enriched their tour experience with added cultural elements** marginally more than the *Video* ($Md = 5$, $IQR = 1$).

Although not statistically significant or marginally significant, participants felt that showing scene-related poems (1) helped them **understand and enjoy the poems** more through *PoeticAR* ($Md = 5$, $IQR = 1$) than through the *Video* ($Md = 4$, $IQR = 1$) and (2) helped them **enjoy the physical scene** more through *PoeticAR* ($Md = 5$, $IQR = 1$) than through the *Video* ($Md = 4$, $IQR = 1$).

6.2. Qualitative results

The interview base on the questionnaire further evaluated the impact of *PoeticAR* compared with the *Video* in the following aspect.

6.2.1. Cultural and aesthetic tour experience with poetry

Participants believed that poems presentation during their tour helped them enjoy the scenery better. Although participants watched the *Video*, they also combined the poems with situated scenery in their minds. As P17 said, "*Poems in the video remind me of the physical scenery, and physical scenery also reminds me of Poems.*" Compared with the *Video*, *PoeticAR* was considered more intuitive and direct by tourists with the combination of virtual poem presentation and physical scene beauty, which provided them an empathetic tour experience and a deep impression, e.g., "*The combination of the static scenery and animated elements with AR technology enhances the beauty.*" (P5), "*The same feeling of the poem contents might give you a deep impression of the natural scenery.*" (P16). Besides, the verse riddle game, AR navigation, and imagery interaction in *PoeticAR* were more engaging to enhance the tourists' empathetic and aesthetic feeling, e.g., P2 said after playing *PoeticAR*, "*This game opened a small window for me to experience the scene, my feeling would be different with the poems' expression and the poets' mood inside the scenic spot.*" "*AR is better to give me one-to-one correspondence between the poem and the scenery.*" (P7). However, the primary aim of tourism is for the physical experience, as the finding in our pre-investigation. The result of *Q6* shows that few participants fully agreed poems did not prevent tourists from enjoying physical scenery whether through *PoeticAR* or the *Video*. As P6 mentioned, "*The presented poetry should not impact the beauty of the scenery and tourists' aesthetic enjoyment.*"

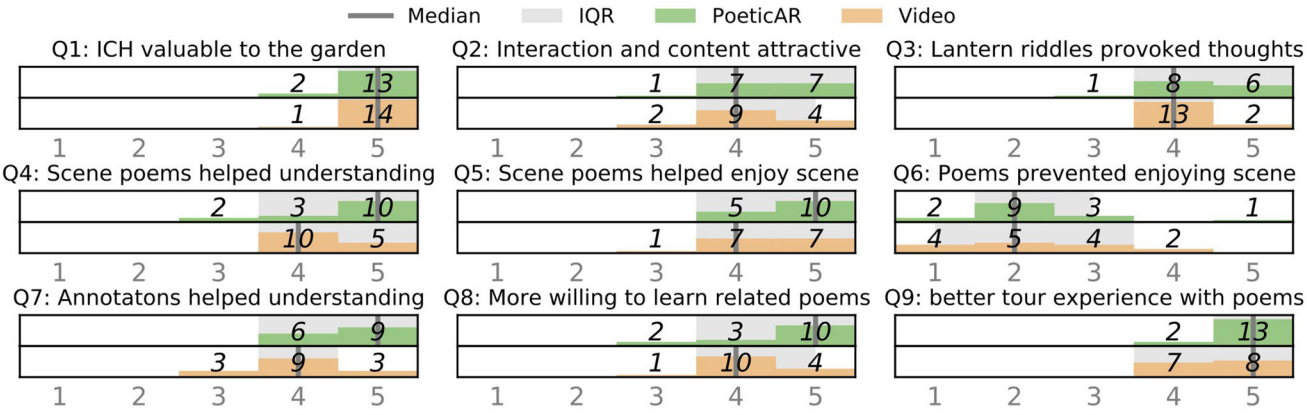

Figure 8. Participants' ratings (1: strongly disagree, 5: strongly agree). The number on each Likert item represents the number of participants who chose it. Questions are shortened to avoid overlapping.

Besides, P22 mentioned, "*If tourists are attracted by over-designed items in AR, nature scenery would be neglected.*"

6.2.2. Poem attraction and understanding in scene

Participants expressed approval that poems presented in the corresponding scene engaged the poem attraction and understanding whether with *PoeticAR* or the *Video*. Poems presented with multimedia contents (i.e., images, music, sounds, texts, calligraphy, and animations) were considered an attractive form, e.g., "*the visualized form of a poem is great.*" (P10). Primarily, the artistic visual content significantly motivated the tourists' interest in poems. As P5 said, "*The presented contents are beautiful, which attracts the further exploration of the connotation of poems and the seasonal scenery depicted in poems.*" Poems presented in AR attracted tourists by providing a fresh feeling and interesting interaction, e.g., "*The refreshing feeling of poems in AR opens up my thinking space, and even expands my mental horizon.*" (P5), "*the interaction with the crane in AR was interesting for the poem appreciation.*" (P13). Besides, *PoeticAR* got a higher score than the *Video* in *Q4 and Q7* for helping the tourists understand the poems with annotations in the scene. Because *PoeticAR* provides the words' annotation and background information on tourists' demands by their active interaction and P3 indicated that "*if the scene motivates my interest in poems, my learning efficiency would be high.*"

6.2.3. ICH access and awareness in CH sites

Both *PoeticAR* and the *Video* prompted tourists' awareness of ICH according to the significantly high score in *Q1*. While *PoeticAR* gave rise to a further willingness to know more situated relevant poems compared to the *Video*, e.g., "*Without AR, It is impossible for me to actively get cultural information in a tour.*" P4 said that "*As a mother, I have known many poems are related to the scenic spot from AR today. Later, I will find more poems for telling my child when we visit the scenic spot next time.*" Although almost all of the participants believe that ICH is valuable for them. However, they mentioned ICH was usually absent in CH sites, but AR or video provided access. As P13 said, "*Cultural tourist attractions lack the promotion of cultural value. Poems delivered via AR are convenient for me when visiting the Chinese garden. If the method of AR can be promoted in the future, it will be beneficial for ICH inheritance, especially for young people.*" *PoeticAR* was considered as a new form of poem presentation to "*extend the physical tour experience with the relevant knowledge of the Chinese garden*" (P1) and to "*allow tourists to get closed to ICH*" (P13).

7. Discussion

7.1. ICH integrate tourism via AR aesthetically

AR presenting the related ICH (e.g., poems) in the situated CH sites provides tourists with a novel aesthetic feeling. Compared with the research that had been done on the preservation and transmission of ICH via AR for the tour experience enhancement (Kromhout & Calvi, 2021; Liestøl, 2018; Shin et al., 2017), *PoeticAR* emphasized the cultural value of CH sites in the aspect of aesthetic enjoyment. Our study shows two features that make people feel aesthetics in the system. First, we designed and integrated **artistic system contents** such as offering CH sites associated poems, beautiful visual presentation, harmonious system style, and graceful scenery overlapping. The perfect AR contents mix the current and ancient beauty. Tourists experience aesthetic feeling beyond the physical scenery beauty from poems that depicted or associated with the CH sites because tourists said that poets' aesthetic perception of the garden reveals the garden's extra beauty. Tourists have empathy with poets from their imagination of poem imagery and cultural connotations of the poem, which provoked their thoughts to connect the ICH and the CH sites. Tourists can simultaneously enjoy the scenery in the AR system. The visual beauty, traditional visual elements, and harmonious style provide additional aesthetic attraction, which open tourists' minds to experience the CH sites. Second, we provided the **hedonic interactive experience** through the verse riddle game and crucial poems' imagery interaction (e.g., crane and fish). The hedonic quality of the system enhanced tourists' aesthetic feeling through gamified experience and vivid interaction. The gamification corresponds with tourists' need for leisure and entertainment during the tour, and exciting interaction engages tourists and offers an easy way to reach the poems' aesthetic imagination. The hedonic interactive experience aroused the tourists' awareness and empathy among the poems, scenes, knowledge, and themselves.

7.2. Design considerations

To answer RQ3, we synthesized the feedback and results obtained from our formative study, prototype, and user study, which result in a list of design considerations for designing AR tourism applications that provide visitors with seamless tourism experiences involving both physical scenes of a heritage site and its associated ICH.

7.2.1. Prioritize the physical experience

The priority purpose of tourists' tours is physical relaxation rather than learning knowledge. According to the finding and results in pre-investigation and user study, tourists prefer to experience and learn cultural values without affecting the beauty of the scenery and the enjoyment of nature. Tourists are concerned that the ICH may prevent their physical tour. Therefore, when designing AR applications that integrate cultural knowledge into tourism, designers should prioritize the physical experience and treat cultural knowledge as an additional supplementary experience. For example, designers can properly show virtual content to upgrade existing physical scenes in selected scenic spots instead of overwhelming the whole tour.

7.2.2. Enhance the physical scenery beauty with corresponding ICH

Our result indicated that both physical scenery beauty and virtual fetching contents of AR attracted tourists. According to tourists' feedback, the artistic presentation of poems should enhance the beauty of the physical scenery. Tourists always thought the artistic visualization of poems was important in their feedback on the AR prototype and *PoeticAR*, or even on the *Video*. In addition, artistic visualization of poems is an excellent approach to present the poems, motivate the tourists' interest in poetry, and make the poem easy to understand. Visual beauty, stylized harmony, fancy imagination, and multisensory feeling of the multimedia contents in AR arouse tourists' aesthetic feelings of ICH and enhance the physical beauty attractiveness to tourists. Thus, we suggest that the artistic presentation of ICH with color harmony, stylized consonance, and imaginative visualization to augment the physical beauty is crucial to enhancing tourists' cultural experience of both ICH and CH sites during tours.

7.2.3. Design ICH-related interactive content

According to our pre-investigation, cultural knowledge (e.g., poems and ancient prose) in books or other carriers inside CH sites is usually unattractive to most visitors. Tourists expect an interesting, exciting, and pleasing way to experience cultural knowledge during the tour. Our user study shows that providing interesting interactions based on ICH content in AR (e.g., verse riddle game, imagery anthropomorphic interaction) can fulfill the tourists' expectations. This is because interesting interactions with embedded ICH content can provoke tourists' thoughts in abstract culture, stimulate tourists' interest in learning, and enhance the empathy between tourists and the ancients. Thus, we suggest AR designers add interesting interactions with ICH content such as traditional elements, classic knowledge, and conventional games to help visitors enjoy ICH in relevant heritage sites but not too much to prevent physical experience.

7.2.4. Provide easy access to ICH with minimal steps

Many participants expected ICH information delivery during their tour to be time-saving, effortless, and with few disturbances in our pre-investigation. Our user study also showed that tourists considered AR a convenient carrier for making poems easy to access. They did not prefer much effort to find ICH information during the tour. Thus, we iterated our AR system by improving its easy usage. We achieved direct and intuitive access to poems through simplified system steps, user-familiar interaction methods, and added voice guidance. Our final AR system allowed the tourists to get ICH information effortlessly and timelessly. We improved our final AR system to present essential poem information first, then offered further optional interaction for additional ICH information. The system improvement streamlined interaction steps, enhanced tourists' willingness to ICH, and satisfied further knowledge requirements. Thus, we emphasize easy access for effective ICH delivery and easy AR system usage without too much interaction and provide users with optional usage for more features.

8. Limitations and future work

This section presents several future directions to improve and extend our current work.

8.1. Extend to location-based application

PoeticAR was for presenting poems for a specific scenic spot in Jichang Garden. Jichang Garden, a CH site, may have many scenic spots. Our findings and design considerations can easily apply to similar ICHs represented in other scenic spots. Our future work will put more effort into extending *PoeticAR* for the application in several scenic spots with location-based features via GPS. The new feature might require additional design. For example, future work can explore how to design transitions in the AR to provide a smooth connection experience among different scenic spots, investigate suitable ways to notify visitors when they get new scenic spots for an AR experience. Besides, tourists suggested that some vanishing scenic spots described in ancient poems could reconstruct in their original locations via AR.

8.2. Personalize experience needs

PoeticAR is currently for a single mobile device application and only considers the general needs of the tourists, so our current research does not cover interviewees' various personal needs. Future work may consider these needs to provide more diverse experiences for tourists. For example, some tourists visit heritage sites in groups. Future work could develop multiplayer interactions in AR for the needs of education, amusement, or communication by the group of tourists. Some tourists already have a fundamental knowledge of poetry. They want the AR system to automatically recommend more related verses according to the intelligent recognition of the scenic elements for their deeper learning needs. Some tourists may be foreign visitors. A Chinese oversea student mentioned the issue in the user study. The AR system might explore the translation feature and research how to provide more cultural information for cross-culture transmission.

8.3. Extend to other ICH and CH

PoeticAR focuses on poetry, which is a typical ICH with cultural and aesthetic value. Other ICH and CH sites can employ our findings and methodology to present the cultural and aesthetic value to enhance the tour experience via AR. However, the extended application may require additional design considerations suitable for the specific features of ICH and the cultural context of CH sites. For example, many traditional Chinese paintings or ancient literati prose associated with CH sites are also worthy of presentation. Due to Chinese painting's stylization, presenting Chinese paintings in AR is harder to combine the painting's virtual

style with the physical scenery coherently than poetry. Ancient prose has more textual content that increases the difficulties in reading through AR and understanding in limited tourism time. The specific characteristics require additional research in future design. Different CH sites may have local taboos, cultural habits, and conscious beliefs in cultural connotation understanding and experiencing. Thus, extra pre-investigations are necessary before starting the AR system design.

9. Conclusion

In this research, we presented an interactive AR system that engages tourists to experience the poems associated with a traditional Chinese garden. We designed *PoeticAR* through formative study and prototype iteration based on the insights from participants. We aimed to enhance tourists' cultural and aesthetic experience of the CH sites beyond the physical experience by revealing the poem's artistic value in situated scenery via AR. To evaluate *PoeticAR* and examine tourists' experience, we conducted a between-subjects user study with 30 participants to compare *PoeticAR* with the *Video*. The result suggested that *PoeticAR* enhanced the cultural and aesthetic experience during the tour, increased tourists' interest in poetry, and improved their awareness of the value of ICH of CH sites. *PoeticAR* efficiently transmitted the knowledge of the poem. Our methodology is not limited to only reviving the poetry of traditional Chinese gardens. Other ICH and cultural contexts of CH sites can employ the methodology to revive the cultural and aesthetic value and to combine the physical and cultural tour experience. We also provided design considerations and future works for designing AR tourism applications that provide seamless tour experiences involving physical scenes of a heritage site and its associated ICH.

Notes

1. https://youtu.be/lp9VD8cleA
2. https://youtu.be/1fKoTo1j8IQ
3. Given the relatively small sample size, we consider $p < 0.05$ as significant, and $0.05 \leq p < 0.10$ as marginally significant, following statistical convention (Cramer & Howitt, 2004).

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