Research on Interactive Design of Intangible Cultural Heritage from the Perspective of Affordances —Take "Jiang Mu" APP as an Example

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Abstract: From the perspective of affordances, this paper explores the interactive design method of intangible cultural heritage, taking Jiang Mu APP as an example to demonstrate the core point of the research. This paper analyzes the affordances characteristics of intangible cultural heritage from three aspects, promotes the dissemination and inheritance of traditional culture by enhancing users' experience and feelings, and further discusses the "Jiang Mu APP", and explores the practical application of the affordances theory in the interactive design of intangible cultural heritage from the perspective of experience, behavior and cultural dissemination, so as to provide new ideas and ways for the interactive design method of intangible cultural heritage, and promote the form and future development trend of digital dissemination of intangible cultural heritage.

Keywords: affordances theory, intangible cultural heritage, interactive design, Jiang Mu APP

1.   Introduction

With the rise of digital protection of material and cultural heritage, digital technology has also been introduced into the protection and dissemination of intangible cultural heritage. Its digital form has gradually changed from traditional digital recording and display to digital restoration and reproduction. Multiple presentation methods can arouse people's interest. The traditional form of protection is mostly offline exhibition of non-heritage museums. Its good cultural atmosphere and detailed explanation provide users with a good visiting experience. However, users need to spend a large amount of complete time visiting, and the time for learning non-heritage culture is often limited in the process of visiting, and the knowledge expansion after leaving the museum is less. In contrast, the development of the non-legacy theme APP enables users to learn using fragmented time anywhere. People's learning is one of the most effective ways to protect and spread culture. Digitalization has created more effective learning methods for people. However, the current learning methods are mostly passive learning. Therefore, exploring the digital form combined with interactive design can enable users to obtain a better sense of experience, effectively promote communication between users and culture, stimulate active learning, and be beneficial to the more effective protection and dissemination of intangible cultural heritage.

2. Affordances theory and interactive design

The concept of affordances was proposed by American ecological psychologist Gibson in the 1980s. James J.Gibson believed that affordances refer to the physical properties that users directly perceive the environment or things through sensory organs. In the 1990s, cognitive scientist Donald Arthur Norman introduced the concept of affordances into the field of design in his book "Design Psychology". Donald Arthur Norman believed that availability refers to the property that the environment or things can provide people with a certain behavior, which determines how things are used. According to people's different memories and experiences, the same things can show different affordances, which may not be available in the environment or the physical properties of things themselves. Rex Hartson divides the affordances into four types according to the theories of James J.Gibson and Donald Arthur Norman: cognitive affordances, behavioral affordances, sensory affordances and functional affordances.

In the field of interaction design, affordances exist between users and virtual interfaces. It refers to the design that provides inspiration for users' possible interaction behaviors, which is fully reflected through the content and interaction methods of software. When people learn through the traditional digital display form, the direction of information flow is relatively simple. The introduction of interactive design enables users to learn again through feedback, thus achieving a multi-direction flow of information and promoting the protection and dissemination of culture.

3. Affordances Analysis of Interactive Design of Intangible Cultural Heritage

Different from the material cultural heritage, the unique intangible embodiment of the intangible cultural heritage lies in the spirit, feelings and national culture conveyed during its formation. As a carrier of intangible cultural heritage, APP on intangible cultural heritage enables people to contact intangible cultural heritage from a variety of perspectives, so that intangible cultural heritage can be spread more effectively. This paper analyzes the affordances of interaction design of intangible cultural heritage from the aspects of product function and interaction model, sensory experience and cognitive behavior, emotional resonance and cultural heritage.

3.1. Product Functions and Interaction Modes

In recent years, the development of APP on intangible cultural heritage has emerged one after another, and the display forms and contents are increasingly rich. From the perspective of functional affordances, the author classifies the APP on intangible cultural heritage into four main categories: APP on intangible cultural heritage with offline display, digital information display, process experience and game entertainment. The main function of the off-line display-type APP on intangible cultural heritage is to assist visitors to visit the off-line intangible cultural heritage museum and get a better experience, including the basic introduction of the exhibition hall, graphic display, voice explanation and AR experience. The main function of digital information display APP on intangible cultural heritage is to display a kind of intangible cultural heritage system in digital form, including pictures, videos, texts, etc. The main function of the process experience APP on intangible cultural heritage is to enable users to experience the intangible cultural heritage through the screen through technical means, including three-dimensional model, AR and VR, etc., such as "Zhe Shan" APP (figure 1). Digital experience means it can effectively improve users' experience [1]. The main function of the game entertainment APP on intangible cultural heritage is to enable people to experience and learn the intangible cultural heritage in a relaxed and pleasant way through games or other forms of entertainment, such as "Nisan Saman", which is a rhythm game with the theme of Saman culture of northern minorities (figure 2).
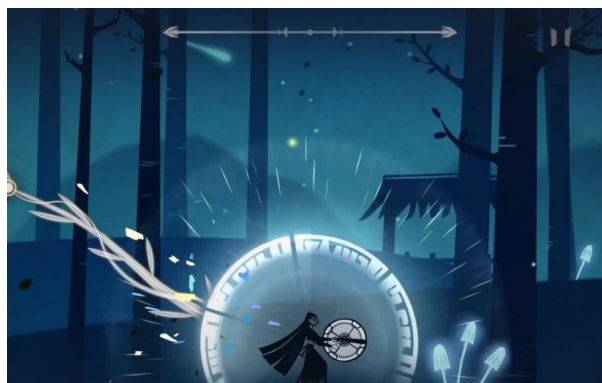
Figure 1: Zhe Shan APP.

Figure 2: Nisan Saman App.

Through the functional affordances arrangement of the above four APP on intangible cultural heritage, the interaction modes between users and the APP on intangible cultural heritage are divided into four interaction modes: text information interaction with text content as the carrier, picture and video interaction with static or dynamic image content as the carrier, embodied experience interaction with virtual experience as the carrier and narrative context interaction with narrative content as the carrier.

3.2. Sensory Experience and Cognitive Behavior

The interactive interface is designed to provide users with the affordances of sensory experience, guide users to recognize and emit behaviors. Sensory experience is the basis of forming emotions [2]. In the process of using APP, APP mainly mobilizes people's vision and hearing, providing sensory experience forming direct perception.

Visual elements include APP's tone style, interface layout, icon elements and model special effects, etc. Good visual elements can meet users' visual needs and have a direct impact on APP's emotional tone. Users generate corresponding psychological expectations before deeply understanding the content of APP. After deeply understanding, people's good feeling of experience will increase when the actual content meets people's expectations. On the basis of improving the visual elements, the auditory elements are added. The coordination and unification of the two elements can effectively improve the comfort of the user experience from multiple angles. The auditory elements include persistent background music or the feedback sound effect when the user operates.

The cognition and interaction of users when using APP can be divided into three processes: information input, information processing and behavior output. The cognitive process of information input involves feeling, perception and attention [3]. Then users process the information briefly through their own memory and experience, and finally feedback the behavior output with touch gestures.

3.3. Emotional Resonance and Cultural Heritage

One of the best ways to protect traditional culture is to pass it on. The core part of intangible cultural heritage, which is also the most difficult part to spread, is the expression of cultural content, the process and skills of production and the experience of word of mouth [4]. Intangible cultural heritage originates from, inherits from and develops among the people. In the same long history, people in different periods always have similar views. Stiff learning cannot effectively spread culture, and should effectively combine ancient culture with modern culture. Therefore, the identity of mobile phone APP is not only a carrier of modern culture, but also a bridge connecting ancient culture with

modern culture, causing emotional resonance between ancient and modern times and enabling culture to be better understood, learned, inherited and developed.

In the process of using APP on intangible cultural heritage, users will have a sense of acquisition and immersion, and the two feelings complement each other. The sense of acquisition is a reflection of how well users think they know about an intangible cultural heritage. When users understand the intangible cultural heritage, too much knowledge, obscure professional terms and complicated operation methods will bring learning burden to users. Therefore, easy-to-learn content is the basis for a good sense of acquisition. Immersion is the embodiment of users' participation in the learning process. Immersion is closely related to embodied experience. Immersion comes from narrative content or technical means, including animation simulation, VR and AR. Inheritance of intangible cultural heritage is the core function of APP on intangible cultural heritage. Good emotional experience can promote users to learn intangible cultural heritage, and experiential learning can enable users to learn knowledge more effectively in the practice process.

4.   "Jiang Mu" APP Interactive Design Practice Analysis Based on the Affordances Theory

At present, more and more attention is paid to the development of serious games in the field of intangible cultural heritage at home and abroad [5]. The basic purpose of serious games in intangible cultural heritage category is education. "Jiang Mu" APP is a puzzle game about tenon and mortise structure, and has won many domestic and foreign game awards since its launch. The mortise-and-tenon structure is another intellectual treasure in the history of China. It does not need a nail or glue. It relies on the precise structure to support the wooden furniture and the daily life of ancient people. According to the above analysis of the affordances of APP on intangible cultural heritage, the analysis of the interactive design practice of "Jiang Mu" APP is carried out from three aspects: immersion experience of three-dimensional technology and virtual reality technology, behavior mode of emotional experience and communication and dissemination of mortise and tenon technology.

4.1.   Immersive Experience of VR Model and Virtual Reality Technology

As an interactive design tool for emotional learning, educational games have always provided people with a relaxed and pleasant way of learning, affecting people's cognition, emotion and behavior [6]. The game's entrance interface and display interface in "Jiang Mu" APP adopt VR model technology (figure 3), which visually provides the first step of an immersive experience for users. The VR model in the "Jiang Mu" game is available for users to perform 360-degree all-round rotation and observation by sliding their fingers. Reasonable blurring of the rear background can highlight the stereoscopic impression of the VR model, enabling users to imagine themselves observing wood in the palm of their hands in reality, bringing an immersive experience. The display interface displays each object in the game and has several different interaction modes with the user. First, the "Jiang Mu" APP uses VR animation to show objects to users, from details to the whole, which can enhance users' understanding of the integrity of objects. Second, like the operation mode of the VR model, the user can perform 360-degree all-round observation on the virtual objects by sliding his finger, or click the button below to combine and split the objects. Third, the user can click on the structure marked on the virtual object to make the structure enlarged and displayed separately for detailed observation. Such technical means bring the user a deeper immersion experience

In addition, the auditory experience is also a key element to enhance the user's sense of immersion. The user can experience two levels of interactive experience on the "Jiang Mu" APP. The first level is the persistent background music. The style of the background music and the style of interactive interface are both classical Chinese style, which enables the user to see and hear consistently and provides the first level of immersion experience. The second layer is the sound effect that can be

superimposed on the background music. When people make selections, draw lines or eliminate them, the game will produce realistic sound effects for interactive feedback, thus deepening the immersive experience of users.

Figure 3: VR model.

Figure 4: Standby interface.

5.   Behavioral Style of Emotional Experience

5.1.   Visceral Level

Compared with abstract text information, people are more inclined to understand visual information [7]. Visceral level mainly involves users' intuitive experience of APP. Visual experience is analyzed from two aspects: interface content design and visual effect.

The main tone of "Jiang Mu" APP is mainly red and brown with warm tone. The tone is gentle and quiet. The overall style is rich in obvious Chinese classical style. It is highly relevant to the theme of the game and provides users with a suitable emotional experience visually. The background of the standby interface of the game is red (figure 4). The central part of the screen uses the tenons and mortises which are dynamically combined to highlight the theme of the "Jiang Mu" APP. The other elements in the screen all use the representative things in Chinese garden culture: the flower of the famous Chinese garden plant magnolia is used as the element in the upper left corner, and the representative KuLong stones in the ancient Chinese garden are used as the element in the lower right corner, echoing with the tenon and mortise buildings in the garden, making the interface design harmonious and unified. In the picture, the light is warm and soft, and the magnolia petals with dynamic special effects float down with the wind, as if telling the leisure and beauty of the ancient carpenter's life, providing users with a relaxed and comfortable visual experience.

The background of the menu interface imitates the red brick wall of ancient China (figure 5). Bamboo shadow is shown on the wall, which represents the spirit of Chinese craftsmen with bamboo. The function buttons in the center are highlighted through the contrast of dark center and bright center around to attract the users' visual attention. The interface design uses classic elements with ancient Chinese characteristics, such as scrolls, woodworking tools and ding (figure 6). The interface design is simple and clear, which can effectively reduce the cognitive load of users [8]. The visual effect is reflected by the fidelity of the virtual model. The game highly restores the shape, texture and use of real objects from the image of each function entrance button. When the user's finger swipes the button to make a selection, the virtual objects in the interface will show the same shaking as if they were actually touched, thus increasing the reality of the user experience. "Practice" is a menu of learning to break through the barriers in the game. It imitates the learning of ancient Chinese. The game uses

scroll design elements. After clicking on the scrolls, the scrolls are unfolded with dynamic special effects, simulating the feeling of people opening the scrolls with their own hands (figure 7). The leftmost end of the scroll borrows the inscription of the bamboo shoot (tenon) in Liang Tongshu's "Zhi Yu Bu Zheng • Sun Mao" in the Qing Dynasty to explain: "The two components are combined by concave and convex parts, the convex part is called tenon, and the concave part is called socket." (figure 8). It can be seen that every detail of the game conveys the knowledge of mortise and tenon to the users.
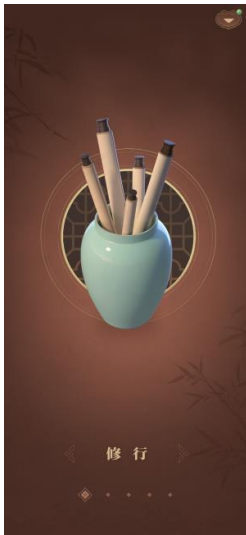
Figure 5: Menu interface. Figure 6: Design elements. Figure 7: Reel opening.
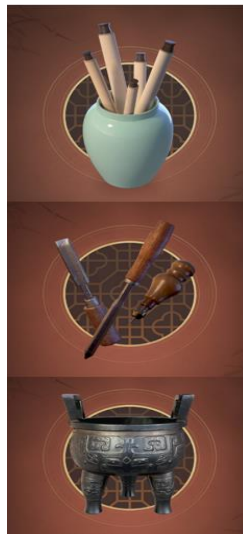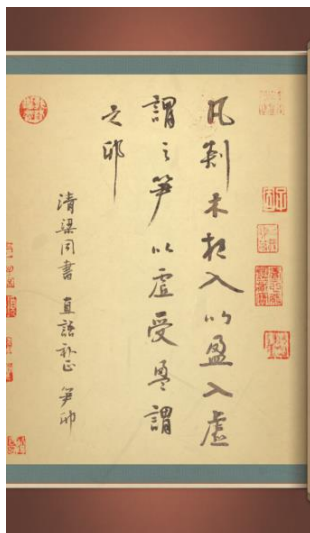

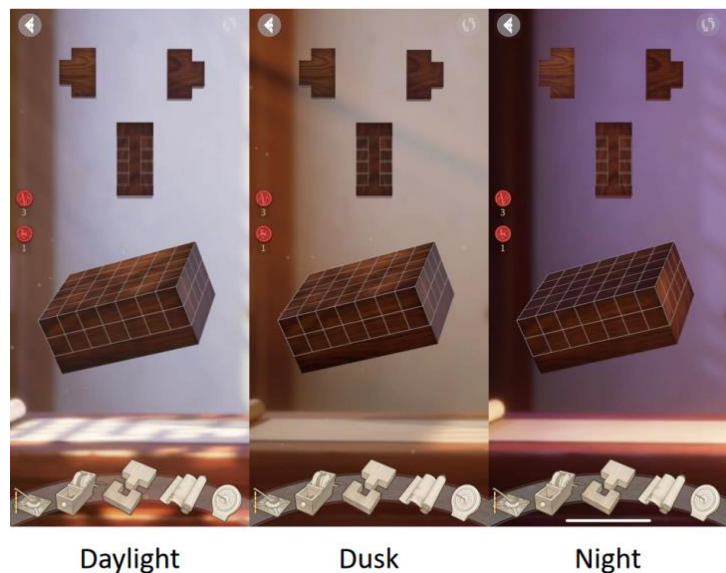Figure 8: Explanation of mortise and tenon inscription.

Figure 9: Light pattern.

When the game interface is presented, the objects have slight changes from small to large, giving people a visual effect from far to near. The function buttons at the bottom pop up from right to left to attract the attention of users. The background of the game interface can switch the three modes of day, dusk and night according to the time of the real world (figure 9), and the mapping effect of the light in the virtual scene changes constantly with the change of different angles of the virtual operation

objects (figure 10). This adjustment mode that echoes the real world makes the user's sense of substitution more intense. In the real world, different wood objects are made of different wood, which is also reflected in the game interface, such as pear, beech and elm (figure 11).


Figure 10: Light effect.
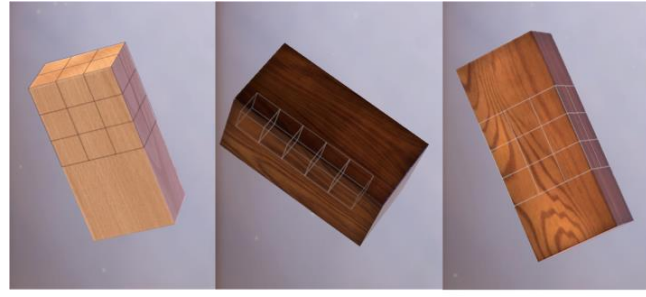
Figure 11: Different woods.

5.1.1. Behavioral Level

In Norman's design psychology, behavioral level design contains four elements: function, understandability, ease of use and good feeling of use. The screen is the medium for users to interact with APP, and the emotional experience of the behavioral level is mainly reflected in the game function area, which is analyzed from the good interaction between "Jiang Mu" APP and users.

The user designs various touch gestures in the game function section, such as clicking, sliding, zooming and rotating (figure 12). Click gesture is the most basic interactive gesture, which is used to open, close or select information. Click again to eliminate it. The sliding gesture is used for large-area operations such as selection of objects and drawing lines. The zooming gesture reduces or enlarges the objects to better observe details. The rotating gesture enables the objects to be presented 360 degrees in all directions. The above various touch gestures change the monotonous operation as before, greatly improving the user's mobile interaction experience, and satisfying the user's emotional experience demand for operation and control from the behavioral level.
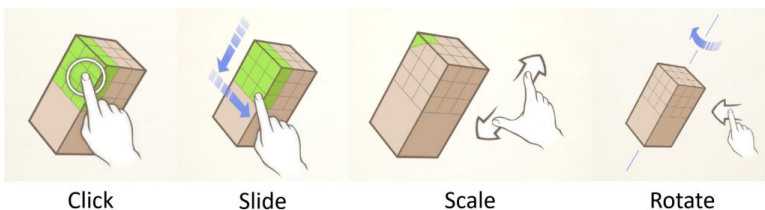
Figure 12: Multiple touch gestures.
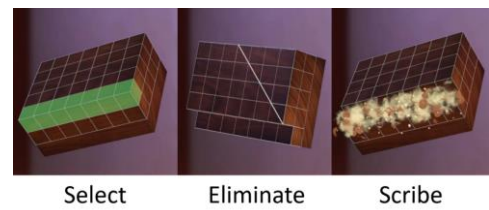
Figure 13: Interactive effects.

Special effects are also a good way to interact with users. For different operations of users, the model has different feedback modes. When users perform selection operations, the selected area will change from the original wood to green to inform the users of the success of the selection. When the scribing operation is performed, the operated area displays lines and moves according to the sliding of the fingers. When the user clicks on the selection area again to perform the elimination operation, the operated part is eliminated and a virtual wood chip is generated to inform the user of the success of the operation (figure 13). The interactive special effect can not only increase the immersion feeling of the user, but also enhance the interaction feeling between the user and the game.

5.1.2. Reflective Level

The emotional experience of the reflective level is analyzed from the user's experience and memory. "Jiang Mu" APP is a decryption game. Too simple a game mechanism will reduce the user's sense of acquisition. Too difficult a game mechanism will reduce the user's sense of achievement and confidence. Too easy and too difficult will affect the user's stickiness with the game. Only a game mechanism with appropriate difficulty can bring a good emotional experience process to the user. The drawing users of the game level can choose whether to disassemble the objects for observation, thus reducing the difficulty of solving the puzzle, improving the usability of the game and increasing the stickiness of the users.

The guide icon conveys emotion through visual language [9], and the image is full of hidden meaning. In the game interface, there are five guide icons, which use "sinan", "ink box", "mortise and tenon joint", "picture scroll" and "sundial", representing the functions of prompt, tool, combination, drawing and cancellation respectively (figure 14). "Sinan" was used to identify directions in ancient times. It represented a "prompt" button in the game, and pointed out directions in the game. "Ink box" is a tool used by carpenters to stretch and straighten the thread. It is used to cut oblique lines on wood blocks to simplify its use in the game. "Mortise and tenon joint" refers to a mortise-tenon joint, which represents a "combination" button for combining objects processed by a user. "Picture scroll" refers to a drawing, which can help users understand how structures are combined. In ancient times, the sundial was used as a time measure, which was related to time and represented the "withdraw" button in the game. Compared with direct guidance icons, metaphorical icon designs are used to arouse the memory and experience of users [10].
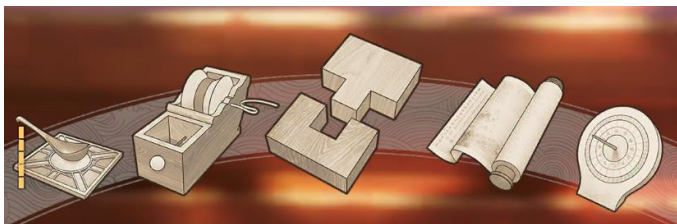

Figure 14: Guide icons.

Figure 15: Knowledge card.

With the enrichment of game functions and contents, the loading time of game applications on the mobile phone interface also increases. Every loading interface when the user waits is designed as a knowledge card about mortise and tenon culture (figure 15), which includes legends, references to ancient books, popular science of objects and introduction of history, etc., so that the user can learn from various angles. Citing ancient books about ancient utensils, such as "Wen Mu Fu", "Chu Ci · Jiu Bian", "Chang Wu Zhi" and "Lu Ban Jing Jiang Jia Jing", can enable users to understand the ancient people's views on woodworking culture in ancient Chinese literary works and arouse the emotional resonance of users. Expanding knowledge, such as the introduction of the ancient building component "bucket arches", makes knowledge acquisition not only limited to mortises and tenons in small objects, and causes users to learn deeply in the comparison of similarities and differences of similar things. Users can learn about the past lives of woodworking culture through the knowledge cards introduced by history, take history as a mirror, look forward to the future through history, and promote the development and dissemination of woodworking culture. This design method not only reduces the user's boredom while waiting, but also enables the user to learn in fragmented time, triggering the emotional resonance of the user.

5.2. Communication and Dissemination of Mortise and Tenon Joint Technology

As written by Liang Tongshu, the combination of emptiness and surplus is a mortise and tenon joint. In its processing, tools such as adze, chisel, axe, saw and ruler are usually used. Wooden parts can be tightly connected without one nail and one glue. It has been widely used in ancient furniture and buildings in China. It embodies the outstanding wisdom of ancient Chinese carpentry. Its complexity makes many people feel intimidated. "Jiang Mu" APP digs for the playability of intangible cultural heritage itself [11], taking different mortise and tenon structures as different game levels. The prototype of each mortise and tenon structure is taken from a specific part of a traditional Chinese object. In order to enable users to better learn and successfully pass the barrier, the "Jiang Mu" APP will transform the complex mortise and tenon structure, so that the mortise and tenon structure in the game will appear in the user interface with a more concise and understandable shape. Users will have a simple understanding of the game interface and operation mode when they first come into contact with the "Jiang Mu" APP, and then gradually pass through various levels, from easy to difficult, step by step. Cultural heritage games enable users to access culture regardless of age [12]. The communication and dissemination of mortise and tenon technology in "Jiang Mu" APP are mainly divided into two ways.

The first is that users learn about the mortise and tenon process through their own learning. In the process of using APP, users participate in active learning and passive learning simultaneously. Reward mechanism can promote users' active learning [13], and failure can promote users' passive learning. Users can successfully pass the barrier by simply learning and thinking or dismantling the schematic diagram on the drawing sheet. If users want to get rewards, they need to pass the barrier in an optimal way, which encourages users to think deeply in the process of repeated deliberation. Below the interface where the operation is successful, the user's excellent degree of successful operation is represented by icons and words respectively (figure 16), "perfect fit" (Yan Si He Feng) refers to the accuracy of the user's operation, "keeping one's heart in one's head" (Cheng Zhu Zai Xiong) refers to the user's clearance through fewer steps, and "keeping one's breath" (Yi Qi He Cheng) refers to the user's absence of redundant actions during the operation. If you pass one level under an object in an optimal way, you will be rewarded with a full star. If you pass all levels under the object successfully, you will be rewarded with the VR model of the object and you will be rewarded with a little effort.

Figure 16: Display of level results.

In the game, the number of users' operation failures is often more than the number of successful operations. Errors can motivate users to learn better and think more deeply, and promote users' passive

learning. In the "Jiang Mu" APP, users will not be punished for their failed operations, so even if they fail, users will not have a psychological burden. Users can even try to find the right way to go through the process. When the operation fails, the interface will display the failure reasons, "such as incomplete" and "success or failure" so that the user can better modify.

Figure 17: "Jiang Mu" APP is jointly signed with the documentary "Papa's Carpentry House"
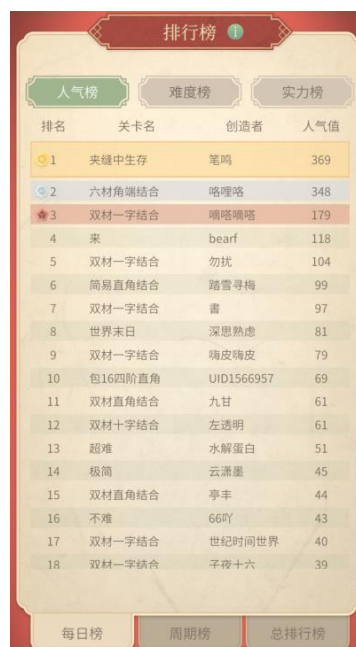

Figure 18: Ranking chart.

"Papa's Carpentry House" records and inherits carpentry skills and culture with the camera lens, which has been well received on the Internet. The "Jiang Mu" APP and the documentary "Papa's Carpentry House" jointly signed (figure 17) to reproduce the popular works therein, enabling the audience of the documentary and the users of the "Jiang Mu" APP to move in two directions, thus attracting more users to understand carpentry culture.

The second type of users is to communicate with other users. One section of the game is the "Contest" section, which provides users with the communication of mortise and tenon culture. Users can create and make their own tenon and mortise structures in the "competition" section and release them for others to decrypt. Users can choose wood and background according to their own preferences to attract other users. If they want to create a complex structure, they need to unlock the corresponding level. Users can also learn about other users' challenges based on the daily update of the ranking list, including "popularity list", "difficulty list" and "power list" (figure 18). In this way, the user can acquire the input knowledge and output it, which enables the user to apply what he has learned and greatly promotes the communication and dissemination of culture.

6. Conclusions

With the rapid development of science and technology, compared with the traditional digital protection method, the emerging digital protection method occupies an increasingly important position. AR and VR technology are widely applied in the protection and inheritance of intangible cultural heritage. The information age provides people with more ways to acquire knowledge. However, people's learning about things is not only satisfied with the one-way flow of information, but also pursues interactive experiential learning. Therefore, the introduction of interactive design

can meet people's needs for feedback learning, enable more people to have close contact with culture and experience culture, form effective two-way information exchange, catalyze the integration and common development of modern culture and ancient culture, and enable intangible cultural heritage to be protected and inherited more effectively.

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