

An Analysis on User Needs for the Design of Liaocheng Canal's ICH Serious Game

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Abstract:

The Liaocheng section of the Grand Canal is rich in intangible cultural heritage (ICH), but many local young people do not know about them. The main reason for this problem is that the way of displaying and disseminating Canal ICH is too traditional, lacks a sense of the times and participatory, and cannot satisfy the needs and aesthetics of young people. With the development of digital technology, serious games bring new opportunities to spread and learn ICH. However, ICH serious games in the current Chinese market face the problems of lack of user engagement and low user satisfaction. It becomes especially important to analyze user needs before game design and development. The purpose of this study is to collect users' requirements for the design of Liaocheng Canal's ICH Serious Game in order to determine the design strategy of this game. The study adopted a quantitative approach, using online questionnaires to survey users' design preferences for the game in four aspects: learning, storytelling, gameplay, and user experience. The results of this study show the prioritization of users' needs for each layer and element of the game, providing targeted insights for future development, as well as clarifying core needs and providing new design ideas and references for other ICH serious game developers.

1. Introduction

As a World Heritage site, China's Grand Canal holds a wealth of intangible cultural heritage. Its protection and promotion of public awareness about its relevance to the contemporary era are crucial for cultural inheritance and innovative development[1]. Liaocheng section, located in the middle of the Jing-Hang Grand Canal, is an important part of the Grand Canal of China. In the World Heritage List, Liaocheng, as an important city through which the Shandong Canal flows, has three sections of river, ranking first among the cities along the canal in Shandong province. As the ancient capital of the canal, Liaocheng has a large number of intangible cultural heritage[2]. Among them, the national intangible cultural heritage representative projects are Dongchang New Year wood-block paintings, Dongchang calabash carving, Liaocheng acrobatics, Langzhuang dough sculpture, Shanshan Guild Temple fair, etc., all of which are important parts of the Grand Canal ICH, and the construction of the

Grand Canal Cultural Belt, the protection and research of these aspects is essential[3]. At present, residents along the Canal of Liaocheng lack of understanding of canal culture, especially young people, do not know the customs, stories and traditional crafts of the Liaocheng's canal culture[4]. In addition, some culture and heritage in Liaocheng are gradually disappearing due to the lack of inheritance of young people in the area[5]. The main reason for this problem is that the way of displaying and disseminating Canal ICH is too traditional and outdated in the current digitalized context, lacks a sense of the times and participatory, and is difficult to satisfy the needs and aesthetics of the young people, making it difficult to attract their attention and interest[6].

According to China QuestMobile 2024 Mobile Game Industry and Key Population Insight Report [7], in February 2024, the scale of China's university student population using mobile game apps reached 19.52 million, and playing digital games became one of the main extracurricular activities for university

students. In addition to being a form of recreation, digital games can also be used for learning, making the learning process more engaging [8]. With the development of digital games, serious games have emerged. serious games are digital games created not only for the purpose of pure entertainment, but with the intention of serious use as in training, education, tourism or cultural heritage [9]. Relevant research shows that serious games can not only be used for cultural education, but also support the preservation, reproduction and experience of cultural heritage, thereby promoting cultural awareness [10]. Serious games have emerged as one of the most promising ways to support the preservation and inheritance of ICH [11]. Serious games present educational content in a fun and interactive way, bringing intangible cultural heritage closer to younger user groups [12]. Valentin Riemer et al. [13] noted that students generally have positive attitudes toward using serious games for learning. Serious games can effectively stimulate university students' interest in learning [14]. Therefore, showing and spreading the intangible cultural heritage of Liao Cheng Canal to university students through serious games can attract their interest in learning canal culture and enhance their understanding of canal culture. However, so far, there has been little research done on the application of serious games to present & disseminate Liao Cheng Canal ICH. Therefore, how to use serious games to effectively display and preserve the information of Liao Cheng Canal ICH, and provide young people with more interesting, effective and useful cultural experience through games, so as to promote the inheritance and development of Liao Cheng Canal ICH has become particularly important.

In China, serious games are also known as functional games. The 2022 China Functional Game Industry Report [15] released by the Social Value Research Center of the China Game Industry Research Institute shows that by 2022, China's functional game users will be about 55 million, and the layout of functional games in many fields has formed an initial scale, in which the functional games themed on traditional culture, education and popularization of science, medical and health care, etc. have developed at a remarkable speed. However, compared with the scale of 664 million game users nationwide, the current user share of functional games in China is low, lacking long-term user stickiness, and the number of functional game products that have gained a good reputation among users is very limited [16]. It indicates that users are less satisfied with the current functional games in the Chinese market, and a survey is needed to understand the needs of users and to obtain reference

data for design guidance, so as to improve user satisfaction [17]. As the market for serious games continues to expand, the target users of serious games have become segmented and refined. Identifying the target users, fully understanding and satisfying their needs is the key to serious game design. Understanding the characteristics, preferences and behaviors of the target group helps to choose the right game type and the way of presenting the game content, to develop games that are more in line with the target group, and to improve the satisfaction and effectiveness of the game [18]. Using a quantitative research method, this study investigated the needs of university students for designing Liao Cheng Canal's ICH Serious Game. Through this study, we will understand the attitude of college students towards the current ICH serious games, obtain their specific needs for this game design in terms of learning, story, gameplay and user experience, and finally determine the user's design preference for this game. These results will be interpreted and applied to develop a serious game for Liao Cheng Canal ICH.

2. Material and Methods

This study is a quantitative data collection method to prioritize user requirements during the pre-development phase of the game. The method proved to be feasible and effective, and the data provided further insight in requirement prioritization than a qualitative approach could provide [19-21]. It is possible to accurately determine user needs and their importance rankings for Liao Cheng Canal's ICH Serious Game. This survey received ethical approval from the Human Ethics Committee of Universiti Sains Malaysia with the approval number USM/JEPeM/PP/24050395, The survey was conducted from January 2024 to March 2024 at 2 universities in Liao Cheng City, Shandong Province, China.

2.1 Recruitment and Procedure

We limited participants to first - to fourth-year university students with experience playing digital games. The anonymous online survey was distributed through Wechat student groups of First-year, Second-year, Third-year and Fourth-year. Participants were presented with an informed consent form that included information about the research project, data protection and voluntary participation before they began answering questions. After reading the informed consent form, participants can freely choose to participate in the questionnaire survey or withdraw. They can also withdraw at any time during the questionnaire filling

process. The survey collected 574 completed survey forms, 3 invalid forms were excluded, balance total 571 valid sets of data.

2.2 Questionnaire Design

After collecting the research questions and variables of this study, 40 questions were designed according to the required variables, including single choice, multiple choice and scale questions. The questionnaire consists of six parts, personal information, learning, storytelling, gameplay, user experience, and user participation attitude. The first part of the questionnaire is mainly a survey of the basic information of the respondents, including the gender, grade, major, understanding of the intangible cultural heritage of the Grand Canal, whether they have experienced serious games of intangible cultural heritage, the reasons for playing serious games and the existing problems of serious games [22]. The design of the second, third, fourth, and fifth parts of the questionnaire mainly refers to the DPE theoretical framework. DPE as a basis to order and categorize the essential elements to be considered when planning serious games [23]. In addition to the single- and multiple-choice questions, four subscales were included: a learning layer subscale, a storytelling layer subscale, a gameplay layer subscale, and a user experience layer subscale, all on a 5-point Likert scale. The specific item design of the scale mainly refers to the GUESS scale and other relevant literature [24-28]. These four parts focus on investigating the specific needs of users for each layer of the game's learning, story, gameplay, and user experience. The learning layer covers intention, learning content and game types. The storytelling layer includes aspects of game story, game characters, game world and game rules. The gameplay layer includes Operation and Control, incentive mechanism, game missions, and game immersion. The user experience layer includes visual, musical and dynamic. The last part of the questionnaire was about the user participation attitude. The questionnaire added an "Other" option to each question, with a text-fill-in area. Participants can use this to enter their thoughts and comments beyond the preset options and express their opinions in their own words. After the preliminary questionnaire was structured, it was further revised based on feedback from two research experts in the field of Game-based Learning in order to confirm the final version. A pilot survey was conducted to validate the reliability and validity of the questionnaire scale design. 50 Liaocheng University students participated in the pilot survey. The Cronbach's α values for all scale items were above 0.9, and the KMO value above 0.8, indicating that

the questionnaire demonstrated good reliability and validity[29].

2.3 Statistical Analyses

First check the integrity and rationality of the data. Respondents who did not agree to the informed consent form or did not complete all questions of the questionnaire were excluded. In addition, statistical analyses were focused on selected questions, which are directly related to game development, prioritization of needs mainly for the four levels of subscales, and specific needs analyses for game elements with higher needs. Descriptive data analysis using Microsoft Excel 2019 and SPSS version 22.

3. Results and Discussions

3.1 Characteristics of the Subjects

This study collected a total of 571 questionnaires, all of which were valid. Table 1 shows that among the 571 respondents, there were 229 (40.11%) males and 342 (59.89%) females, and the proportion of gender was balanced. The respondents involved different majors in literature and history, science and technology, art and sports, and agriculture and medicine from First year to Fourth year. Most of the respondents had a Moderately understand (47.99%) of Liaocheng Canal ICH. They knew some ICH projects, but did not know the details.

3.2 User's Attitude Towards ICH Serious Game

A total of three questions were asked to survey participants' attitudes towards current ICH serious games. Table 2 shows that 56.04% of respondents haven't played ICH serious games. Those who have experienced such games focused on traditional arts and crafts (18.74%), and traditional production, practices/knowledge and skills (10.68%). Survey data shows that users play ICH serious games mainly for visual aesthetics (78.63%), fun gameplay (66.90%), and learning ICH knowledge (66.20%), indicating users prioritise aesthetics and fun over cultural learning. Insufficient promotional efforts and lack of game operations (58.67%), the lack of interesting mechanics in the gameplay (51.31%), and the heavy educational nature (50.61%) are the main problems existing in the serious games of ICH.

3.3 User Needs for Four Layers

The user needs analysis for Liaocheng Canal's ICH Serious game includes four aspects of needs:

Table 1. Profile of Respondents

Characteristics	Options	N	Percent (%)
Gender	Male	229	40.11
	Female	342	59.89
Grade	Degree - First year	274	47.99
	Degree - Second year	85	14.89
	Degree – Third year	149	26.09
	Degree – Fourth/Final year	63	11.03
Major	Literature & History	80	14.01
	Science & Technology	159	27.85
	Arts & Sports	227	39.75
	Agriculture & Medicine	34	5.95
	Others	71	12.43
What is your level of knowledge about the ICH of Liaocheng section of the Grand Canal?	Not understand at all	29	5.08
	Not very Understand	163	28.55
	Moderately understand	274	47.99
	Understand	77	13.49
	Very understand	28	4.9

Table 2. User's Attitude towards ICH Serious game

Questions	Options	Percent (%)
Have you ever experienced playing the following types/categories of ICH Serious games?	No experience at all so far	56.04
	Traditional arts and crafts	18.74
	Traditional production, practices/knowledge and skills	10.68
	Traditional festivals and ceremonies	7.88
	Traditional Performing Arts	5.60
What are the reasons that make you want to play ICH serious games?	Able to enjoy cultural visual aesthetics	78.63
	Able to experience the fun gameplay of ICH	66.90
	Be able to learn about ICH culture	66.20
	Be able to immerse in the game's storyline	58.32
	Be able to appreciate the social value of games	46.58
What do you think are the existing problems with ICH serious games?	Insufficient promotional efforts and lack of game operations	58.67
	Single gameplay and lack of interesting mechanics	51.31
	The content is less interesting with a heavy emphasis on educational nature	50.61
	Limited storyline, unable to provide a long-term gameplay experience	39.93
	Overloading with cultural elements while missing the core cultural essence	37.13

Learning, Storytelling, GamePlay, and User Experience. Table 3 shows that the mean per item score for each subscale exceeds 4, indicating high user demand across all four aspects, with User Experience has the highest demand (M=4.234), followed by Learning (M=4.172), Storytelling (M=4.138), and GamePlay (M=4.075). It shows that a good sensory experience is a key factor in

determining the popularity of a game in the minds of users.

3.4 Learning layer needs

Table 4 analyzes the overall needs of users at the learning layer, and the mean scores show that the

Table 3. Description of four layers

Dimension	Mean	Item	Mean per Item	Sort
User Experience	42.342	10	4.234	1
Learning	29.203	7	4.172	2
Storytelling	107.555	26	4.138	3
GamePlay	89.642	22	4.075	4

content needs to be diverse and rich (M=4.228) has the highest mean value, indicating that users attach great importance to the richness of learning content. It is closely followed by encourages full unleash of creativity and imagination (M=4.222), indicating that encourages full unleash of creativity and imagination also plays an important role in the hearts of users. This means that in game design, it is important not only to provide a wealth of intellectual content, but also to create a space for the player to give full play to their creativity and imagination. Ranking third was the learning content not boring (M=4.210), indicating that keeping the learning content interesting is always a key factor in engaging users in learning. When designing the game, it is important to present the rich variety of content and creative aspects in an interesting way, and avoid boring knowledge instillation. Table 5 shows that users wanted to achieve both learning and

entertainment through Liaocheng Canal's ICH Serious Game, and the Mean per Item scores for both aspects were above 4, and the scores were relatively close to each other. For learning, raising awareness of cultural heritage preservation (M=4.180) is the strongest purpose. For entertainment, users preferred Realization of leisure and recreation (M=4.075), followed by Gain a Collection Achievement and Experience the joy of competition.

Regarding the learning content, as seen in Table 6, users show a high interest in all aspects of Liaocheng Canal culture, among which the top three are canal history (77.76%), folklore stories (77.06%) and traditional crafts (74.43%). The analysis of Game type preference Figure 1 uses a bar chart and it is very straightforward to see that the largest number of users chose RPGs (29.95%), followed by simulation games (21.19%).

Table 4. Description of Learning layer

Item	Mean	S.D
clear objectives	4.107	0.899
The learning content not boring	4.210	0.885
The content needs to be diverse and rich	4.228	0.859
Effective learning of ICH content with experiential learning	4.168	0.874
encourages me to Learn by Doing	4.128	0.884
encourages the practice of ideal behaviour in real-life	4.140	0.899
encourages full unleash of creativity and imagination.	4.222	0.885

Table 5. Mean scores of the Intention

Dimension	Item	Mean	S.D	Sort	Mean per Item
Learning Intention	Raising awareness of cultural heritage preservation	4.18	0.879	1	4.084
	Learning about Intangible Cultural Heritage	4.075	0.927	2	
	Learn about the history and culture of Liaocheng Canal	3.996	0.979	3	
Entertainment Intention	Realisation of leisure and recreation	4.075	0.938	1	4.019
	Gain a Collection Achievement	4.068	0.963	2	
	Experience the joy of competition	3.914	1.039	3	

Table 6. User preferences for learning content

Questions	Options	Percent (%)
What aspects of Liaocheng canal culture do you hope to learn in the game?	History of Liaocheng Canal	77.76
	Folklore stories	77.06
	Traditional Arts & Crafts	74.43
	Local folklore and traditions	72.68
	Important buildings and landscapes along the canals	72.50

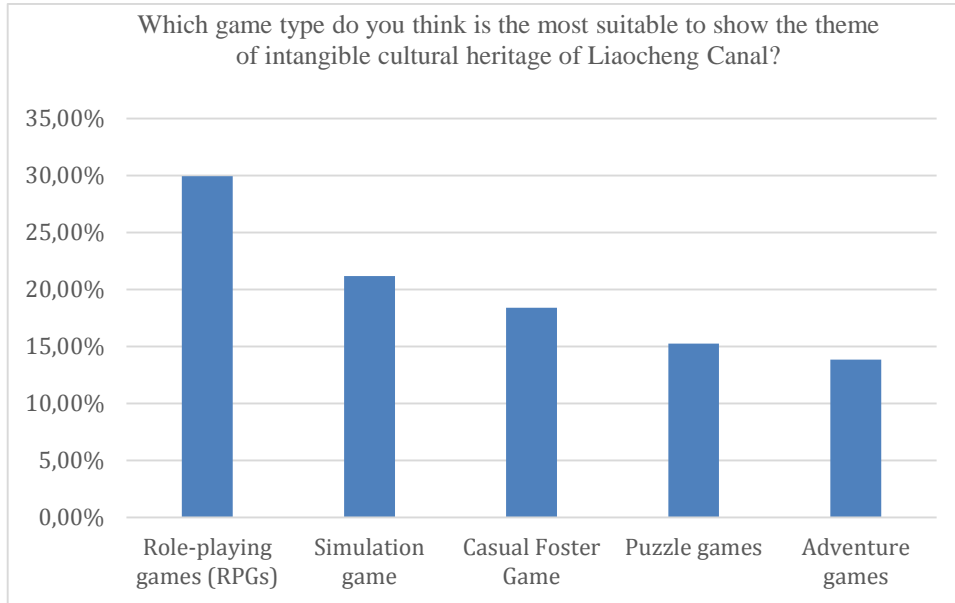


Figure 1. User preferences for game type

Table 7. Description of Storytelling layer

Dimension	Mean	Item	Mean per Item	Sort
Game story	49.765	12	4.147	1
Game rules	20.716	5	4.143	2
Game characters	20.610	5	4.122	3
Game worlds	16.464	4	4.116	4

3.5 Storytelling layer needs

Table 7 shows the prioritization of users' needs for each element at the story layer, including game story, game rules, game characters and game worlds. The mean per item of each element was more than 4 points, indicating high user demand in all four areas. Game story has the highest demand (M=4.147), indicating that users attach great importance to the quality, plot richness and attractiveness of game story. Game rules (4.143) is slightly lower than game story, and the scores of both of them are extremely close, indicating that users hope that game story can be deeply integrated with game rules, with stories guiding the understanding of rules and rules enhancing the Story experience. This was followed

by game characters (M=4.122) and game worlds (M=4.116).Figure 2 shows the user preferences for game story. At story and gameplay integration, the most users choose that story and gameplay should be closely integrated and mutually reinforcing (36.08%). Regarding narrative structure, the most users chose multi-linear narrative structure (40.28%). Regarding the historical authenticity of the story, the most users chose Inspired by history, but creatively adapted (32.75%).

3.6 GamePlay layer needs

Table 8 presents the prioritization of users' needs for each element at the gameplay layer, and the analysis

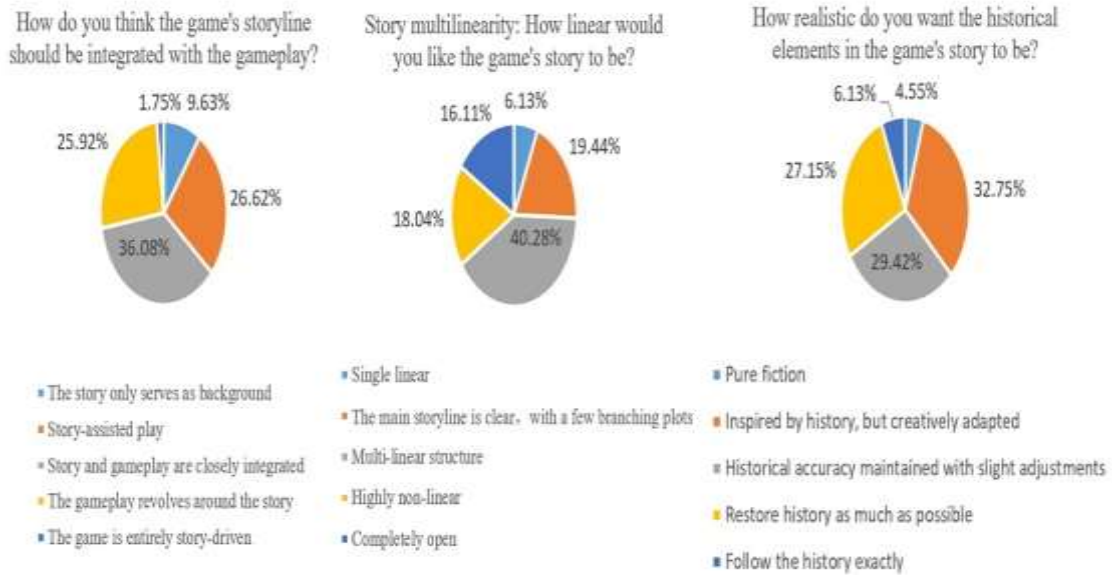


Figure 2. User preferences for game story

Table 8. Description of GamePlay layer

Dimension	Mean	Item	Mean per Item	Sort
Game missions	16.58	4	4.145	1
Incentive mechanism	37.087	9	4.121	2
Operation and control	16.330	4	4.083	3
Game immersion	19.645	5	3.929	4

Table 9. Description of User Experience layer

Dimension	Mean	Item	Mean per Item	Sort
Visual effect	12.803	3	4.268	1
Dynamic effect	12.688	3	4.229	2
Musical effect	16.851	4	4.213	3

results show that the mean per item for Game missions, Incentive mechanism and Operation and control are all greater than 4, indicating that users have high demands for these three aspects. Game missions have the highest demand (M=4.145), followed by Incentive mechanism (M=4.121) and Operation and control (M=4.083). Game immersion (M=3.929) is slightly lower than the other three. Show that Game missions are a key factor in keeping players engaged in the game, and users desire to have a diverse, challenging and fun mission experience.

3.7 User Experience layer needs

Table 9 presents the prioritization of users' needs for each element of the user experience layer, and the results of the analysis show that the mean per item

score for each subscale exceeds 4.2, indicating users have high expectations of the game in terms of visual, auditory and dynamic presentation, all of which are important in shaping a quality gaming experience. Visual effect has the highest demand (M=4.268), followed by dynamic effects (M=4.229) and musical effects (M=4.213). It shows that users are extremely concerned about the visual presentation of the game.

According to the results shown in Figure 3, it can be clearly seen that users have preferences for visual style and graphic elements. In terms of visual style, ancient style is the first choice of users with a proportion of 52.71%. In terms of graphic elements, 49.39% of users tend to accurately reproduce the historical details and hope to extract the aesthetic elements related to the Canal ICH in the design of the game's graphic elements.

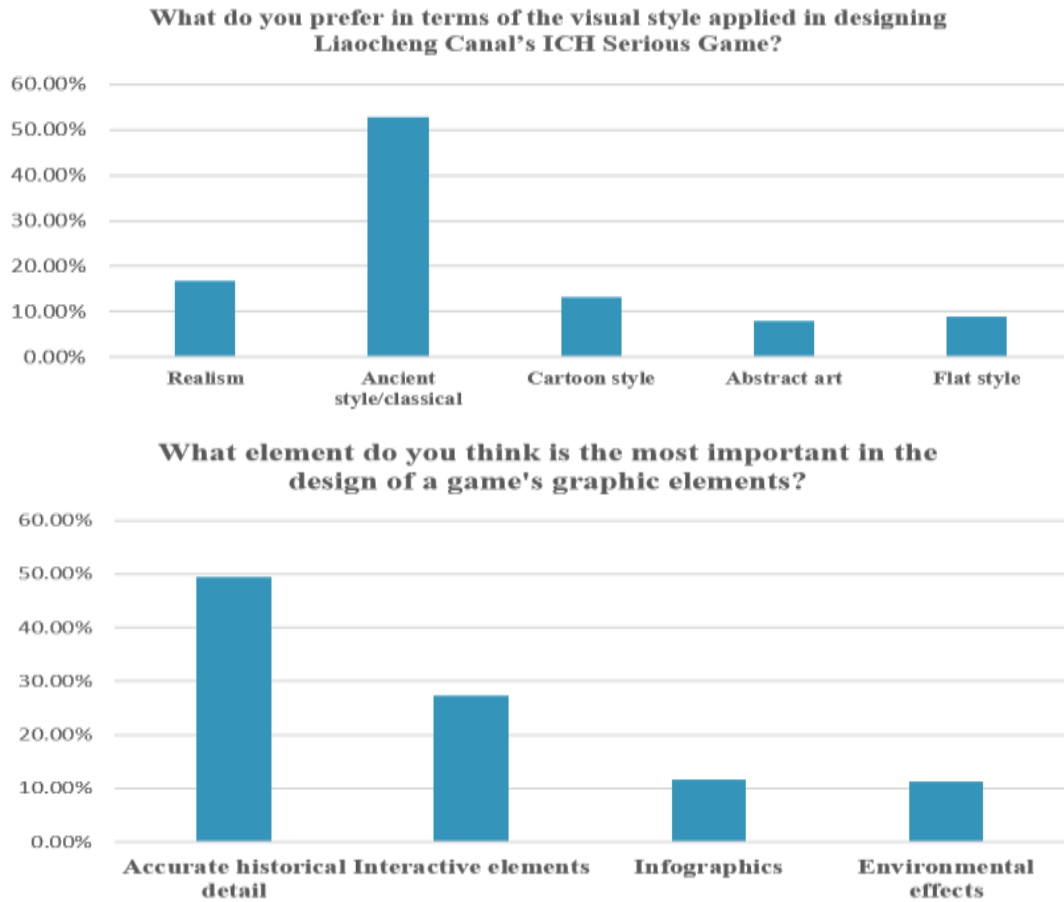


Figure 3. User preferences for Visual effect

4. Discussions

This study adopts a quantitative research method and a questionnaire design based on the DPE framework to deeply analyze the needs of target users for the design and development of Liaocheng Canal's ICH Serious Game from four dimensions: learning, storytelling, gameplay, and user experience. The researcher collected a total of 571 valid data, and the participants covered freshmen to seniors of all majors in 2 universities in Liaocheng area. The demographic information data of this study showed that the university students in Liaocheng area had a moderately low level of knowledge about canal ICH, they have heard about some ICH projects, but did not know the specifics such as its history, craft characteristics, and legends and stories, which is consistent with the relevant studies mentioned in the introduction.

The analysis of User's Attitude towards ICH Serious game shows that the popularity of this type of game in the market is low. Compared to other mainstream game genres, ICH Serious games may have a relatively narrow audience targeting and have not yet succeeded in attracting a wider group of gamers. This also reflects the fact that ICH Serious games have great challenges in market expansion, but also

contains greater development potential[30]. The study finds that users who have experienced such games pay more attention to traditional arts, crafts, and traditional production themes, indicating that these users have a higher interest in the material carrier and practical operation level of ICH. As opposed to ICH knowledge learning, the visual presentation and entertainment of the game play a crucial role in engaging players. Most users consider insufficient promotion and insufficient game operation to be the main problems with this type of game, which highlights the importance of game marketing and subsequent operation and maintenance. In terms of game design, the main problem is that the gameplay lacks fun and is heavily educational. This reflects that the game fails to find a good balance between entertainment and education[31]. The game design should increase the variety and innovation of gameplay. At the same time, when integrating ICH knowledge, it should be combined with game play to avoid instilling knowledge that is too rigid, but rather to educate players in a subtle and interesting way[32].

The results of the participants' needs analysis of the design of Liaocheng Canal's ICH Serious Game showed that, from the perspective of importance of the needs, users had the highest need for user experience. Therefore, providing a contextualized

multi-sensory experience that highlights visual aesthetics and cultural regional features is key to attracting users' attention. Han et al. [33] noted that users are initially motivated to capture and hold their attention through situational awareness. This study further validates this and states that users have the highest demand for visual aesthetics. Therefore, a good audiovisual sensory experience is the basis for the effective presentation of other dimensions.

Second is the learning demand, providing rich and interesting ICH knowledge is crucial to users' willingness to play the game. This study found that users are more interested in the history, legends and stories, and traditional crafts of canal culture, and the knowledge content of these three aspects can be mainly presented in the game design. This layer emphasizes the accuracy of cultural knowledge and therefore requires the involvement of ICH inheritors and cultural experts. Designers need to create space for players to give full play to their creativity and imagination while ensuring the accuracy of the knowledge. The results of this study show that RPGs are the most favored game type [34]. In game design, task-driven learning can be adopted, through role playing, so that players can naturally learn relevant knowledge in the process of completing game missions.

Then there's the storytelling needs, where the use of multiple linear narratives to build rich story plots can help enhance the immersion of the experience [35]. The study found that users want stories to be based on real historical and cultural backgrounds, creatively adapted to increase the interest of the story from a young person's perspective. This requires designers to dig deeply into the cultural background involved in the game and integrate cultural elements into all aspects of the story, such as scenes, characters, plot, etc., so that users can truly understand the essence of ICH culture with regional characteristics in an immersive environment.

Finally, there is the needs for game play, which has a slightly lower mean value relative to the other layers, but as an attraction it still significantly influences users' willingness to engage with the game. Single, repetitive gameplay is easy to make players feel boring, designers should combine ICH cultural content, innovative gameplay design. Practical interactive experience is of great significance for the protection and inheritance of traditional handicrafts, as it can enhance users' sense of accomplishment[36]. Interesting and challenging game missions design will help increase user stickiness in the game, and the reward system can motivate users to actively participate in the game.

The current study utilizes quantitative methods to understand user needs in the pre-development phase of the game. This was useful in determining the

design strategy for the prototype of the Liaocheng Canal ICH Serious Game. A qualitative approach using focus group discussions is planned for the next phase to further refine the design ideas gathered from this study. Such discussions enabled the researcher to gather additional insights from designers, experts and participants. Then, based on the needs and insights gathered from the literature and similar games, a prototype of the Liaocheng Canal ICH Serious Game will be developed.

There are some limitations in this study and the main limitation observed is the method of designing the questionnaire. As explained in the questionnaire design section, the researcher compiled questions to capture users' needs and preferences based on the results of previous studies. This could threaten the quality of the data collected as the questions had not been extensively tested before. However, pilot testing and expert review support ensured that the questions were an accurate measure of the concepts in question, and the resulting Cronbach alpha and KMO values also ensured the survey's reliability and validity. Secondly, the quantitative approach to exploring user needs may also be a limitation. However, since open-ended answer options were also added to the questionnaire, respondents were able to express their own opinions in addition to the options. In subsequent research, a qualitative approach will be added to provide a more in-depth and comprehensive understanding of user needs.

5. Conclusions

This study investigates the problems of the current ICH serious games and the user needs for the design and development of the Liaocheng Canal ICH Serious Games, analyzes in depth the specific needs of the users in the layers of learning, storytelling, game play and user experience, and provides targeted design ideas. Compared with existing studies, this study provides a comprehensive analysis of user needs. By identifying the importance of users' needs in various aspects of the game, it provides a more precise guide for the design and development of the Liaocheng Canal ICH serious game. It also clarifies the core requirements for other ICH serious game developers and provides new design ideas and references for designers. Quantitative research provides specific quantitative data to visualize the degree of user preference for different needs. For example, the data shows that among the thematic elements of ICH serious games, traditional arts and crafts and traditional production, practice / knowledge and skills receive a higher degree of attention. This allows ICH games to rationally allocate resources based on these quantitative ratios in content design, and provide

more in-depth and detailed presentations of the key elements of concern, such as increasing the presentation of the aesthetic aspects of traditional crafts and simulation experiences of the production process.

The quantitative data in this study provide basic reference for the subsequent research. In future work, the collected user requirements can be further refined through in-depth focus group discussions.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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References

- [1] Yan C. (2020). The Active Protection and Utilization of Intangible Cultural Heritage of the Grand Canal. *Journal of Hainan Normal University (Social Sciences)*. 33(3):136–140. doi: 10.16061/j.cnki.cn46-1076/c.2020.03.020.
- [2] Zheng M. (2018). Preservation of Canal Cultural Heritage in Liaocheng. *China Ancient City*. 10:93–96.
- [3] Xu Q. and Wang Y. (2018). Cultural Heritage of the Grand Canal (Shandong Section) and its Live Protection. *Theory Journal*. 6:160–168. doi: 10.14110/j.cnki.cn-37-1059/d.2018.06.023.
- [4] Sun J. and Yan Y. (2021). Current Situation and Countermeasures of Residents' View of Canal Culture along Liaocheng Section of the Grand Canal. *Time Report*. 3:54–56.
- [5] Ge X. and Yan Y. (2021). Exploring the Protection Status and Development Strategy of Cultural Heritage of Liaocheng Section of the Grand Canal. *Time Report*. 4:63–65.
- [6] Li J. (2016). The Digital Protection and Communication for the Culture Heritage Resources of Wuxi Canal. *Zhuang Shi*. 8:132–133. doi: 10.16272/j.cnki.cn11-1392/j.2016.08.037.
- [7] QuestMobile 2024 Mobile Games Industry and Key Population Insights, QuestMobile Research Institute. [Online]. Available: <https://www.questmobile.com.cn/research/report/1780065254895620098>
- [8] R. N. Landers and R. C. Callan. (2011). Casual Social Games as Serious Games: The Psychology of Gamification in Undergraduate Education and Employee Training. In *Serious Games and Edutainment Applications*, M. Ma, A. Oikonomou, and L. C. Jain, Eds., London: Springer London. 399–423. doi: 10.1007/978-1-4471-2161-9_20.
- [9] D. R. Michael and S. L. Chen. (2024). Serious games: Games that educate, train, and inform. Muska & Lipman/Premier-Trade, 2005. Accessed: Jul. 13, 2024. [Online]. Available: <https://dl.acm.org/doi/abs/10.5555/1051239>
- [10] F. Laamarti, M. Eid, and A. El Saddik. (2014). An Overview of Serious Games. *International Journal of Computer Games Technology*. 2014:1–15. doi: 10.1155/2014/358152.
- [11] M. Mortara, C. E. Catalano, F. Bellotti, G. Fiucci, M. Houry-Panchetti, and P. Petridis. (2014). Learning cultural heritage by serious games. *Journal of Cultural Heritage*. 15(3):318–325. doi: 10.1016/j.culher.2013.04.004.
- [12] M. Čosović and B. R. Brkić. (2019). Game-Based Learning in Museums—Cultural Heritage Applications. *Information*. 11(1):22. doi: 10.3390/info11010022.
- [13] V. Riemer and C. Schrader. (2015). Learning with quizzes, simulations, and adventures: Students' attitudes, perceptions and intentions to learn with different types of serious games. *Computers & Education*. 88:160–168. doi: 10.1016/j.compedu.2015.05.003.
- [14] Sun H. and Ren Y. (2018). Analysis of strategies in the application of educational games in colleges and universities - the case of university students. *Course Education Research*. 15:34–36.
- [15] 2022 China Functional Games Industry Report," Social Value Research Center, China Game Industry Research Institute, 2022. [Online]. Available: <https://www.21jingji.com/article/20230214/herald/52f5c07e12bee4a7ab2a2accb4984e2b.html>
- [16] Lu Y. (2021). Research on Serious Game Design of Mobile Terminal Based on User Experience. *DESIGN RESEARCH*. 11(6):27–31.
- [17] P. Mao and D. M. Cho. (2024). Research on an evaluation rubric for promoting user's continuous usage intention: a case study of serious games for Chinese cultural heritage. *Front. Psychol*. 15:1300686. doi: 10.3389/fpsyg.2024.1300686.
- [18] R. Dörner, S. Göbel, W. Effelsberg, and J. Wiemeyer. (2016). Eds., *Serious Games*. Cham: Springer International Publishing. doi: 10.1007/978-3-319-40612-1.
- [19] E. Johansson, D. Bergdahl, J. Bosch, and H. H. Olsson. (2015). Quantitative Requirements

- Prioritization from a Pre-development Perspective. In *Software Process Improvement and Capability Determination*. 526, T. Rout, R. V. O'Connor, and A. Dorling, Eds., *In Communications in Computer and Information Science*. 526. Cham: Springer International Publishing. 58–71. doi: 10.1007/978-3-319-19860-6_6.
- [20] M. Weerasekara, Å. B. Smedberg, G. Karunathilaka, and H. Sandmark. (2022). User needs gathering for the design of information and communications technology-supported occupational stress management intervention: A quantitative study. *Digital Health*. 8:2055207622112777. doi: 10.1177/20552076221127778.
- [21] S. L. Holzmann, F. Dischl, H. Schäfer, G. Groh, H. Hauner, and C. Holzapfel. (2019). Digital Gaming for Nutritional Education: A Survey on Preferences, Motives, and Needs of Children and Adolescents. *JMIR Form Res*. 3(1):e10284. doi: 10.2196/10284.
- [22] Gao Y. (2024). Dissertation Submitted to Zhejiang Gongshang University for Master's Degree of Design. *master, Zhejiang Gongshang University*. doi: 10.27462/d.cnki.ghzhc.2023.000525.
- [23] M. Carrión-Toro, M. Santorum, P. Acosta-Vargas, J. Aguilar, and M. Pérez. (2020). iPlus a User-Centered Methodology for Serious Games Design. *Applied Sciences*. 10(24):9007. doi: 10.3390/app10249007.
- [24] M. H. Phan, J. R. Keebler, and B. S. Chaparro. (2016). The Development and Validation of the Game User Experience Satisfaction Scale (GUESS). *Hum Factors*. 58(8):1217–1247. doi: 10.1177/0018720816669646.
- [25] Mai Y. (2025). The Development of Game User Experience Measurement Tool: A Factor Analysis and Item Response Theory Approach. *Master, Tianjin Normal University*. Accessed: Jan. 16, 2025. [Online]. Available: https://kns.cnki.net/kcms2/article/abstract?v=4d8R2eTuy_190J-7wkXj_VMh19Z49VERwjy-qvHiy6Rsm5TKF8TB9ZdrfTuhHvPh_mPQRKcFvPWtz9khafkQD_gyz9eOtWvNDYS-3rhg-gFJz8-paWUH8sWBHL9u8ihdh-awIxrwlC3kKHYPi72VAfgOQvrxGolaLUJA2NOCIwB0fKe6YEq8VVpQ089qG85y0Wqmv0edI=&uniplatform=NZKPT&language=CHS
- [26] Hao Y. (2023). A Study on Solar Term Application Game Design based on User Experience-Taking Solar Term Island Game as an Example. *Master, East China University of Science and Technology*. doi: 10.27148/d.cnki.ghagu.2021.000491.
- [27] R. Dörner, W. Effelsberg, S. Göbel, and J. Wiemeyer. (2016). Eds., *Serious Games: Foundations, Concepts and Practice*, 1st ed. 2016. Cham: Springer International Publishing : Imprint: Springer. doi: 10.1007/978-3-319-40612-1.
- [28] Huang Z. (2023). Serious Game Design Study for Pre-Pregnancy Education Based On Experience Hierarchy Theory. *Master, Zhejiang Sci-Tech University*. doi: 10.27786/d.cnki.gzjlg.2022.000054.
- [29] J. M. Cortina. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of applied psychology*. 78(1):98.
- [30] Tang, Jinyu and Zhu, Xuefang. (2020). Shuzi feiyi chuancheng zhong yansu youxi xiangmu kaifa yu yingyong tantao [Discussion on Development and Application of Serious Game Projects in Transmitting Digital Intangible Cultural Heritage]. *Library and Information Service*. 64:35–45. doi: 10.13266/j.issn.0252-3116.2020.10.005.
- [31] Yang Y., Ji T., and Zhang D. (2020). Design and Application of Cultural Heritage in Serious Games. *Packaging Engineering*. 41(4):312–317. doi: 10.19554/j.cnki.1001-3563.2020.04.046.
- [32] T. Empler, A. Caldarone, and A. Fusinetti. (2024). Immersive Ro(o)me. A Virtual Reconstruction of Rome in 1750. In *Beyond Digital Representation*, A. Giordano, M. Russo, and R. Spallone, Eds., in *Digital Innovations in Architecture, Engineering and Construction*. , Cham: Springer Nature Switzerland. 639–656. doi: 10.1007/978-3-031-36155-5_41.
- [33] M. Han, Y. Ji, G. Lin, L. Liang, and S. Zhong. (2024). A Study on Gamification Design of Intangible Cultural Heritage Based on ARCS Theory. In *Human-Computer Interaction*. 14688, M. Kurosu and A. Hashizume, Eds., in *Lecture Notes in Computer Science*. 14688: 324–342. Cham: Springer Nature Switzerland. doi: 10.1007/978-3-031-60449-2_22.
- [34] A. Muminin, A. B. Sriwarno, and I. R. Mutiaz. (2021). Designing Games To Understand User Preferences Based Player-Centered Design of Indonesian National Heroes: presented at the ICON ARCADE 2021: The 2nd International Conference on Art, Craft, Culture and Design (ICON-ARCADE 2021), Bandung, Indonesia. doi: 10.2991/assehr.k.211228.046.
- [35] F. Vanoverschelde. (2019). No Story without a Backstory: The role and importance of the backstory in an augmented reality application for cultural heritage. In *Proceedings of the 8th International Workshop on Narrative and Hypertext*, Hof Germany: ACM. 1–3. doi: 10.1145/3345511.3349282.
- [36] Y. Hang, H. Wang, Z. Sang, R. Huang, and L. Ye. (2023). The impact of mixed reality serious games on mortise and tenon learning in college students. *Computers & Education: X Reality*. 3:100042. doi: 10.1016/j.cexr.2023.100042.