



Design and Development of an Educational Game Based on Human-Computer Interaction for Solar Terms

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Abstract. The current educational games are lacking and there are many problems. The games either lack interactive fun or are not closely related to culture itself, making them of little educational significance. This study utilized Unreal Engine 4 to design and develop an educational game about solar term culture. Players play the role of a farmer in the game, understanding and learning about the 24 solar terms through the interaction of eight solar terms in the four seasons and various interaction systems. Through the analysis of user research results, the game has received high evaluations in terms of gameplay, education, and user stickiness. This study explores the application of game design in cultural education from the perspective of user experience, and explores game design methods applicable to solar term cultural education. The feasibility of using educational games for solar term culture education has been verified through design and development. Exploring new ways and forms of effective dissemination of traditional culture in the digital age has played a certain driving role and has certain pioneering and research significance.

Keywords: Unreal Engine · solar terms · educational game

1 Introduction

1.1 Research Background

The 24 solar terms are the traditional time system in ancient China, which divides the year into 24 solar terms, each of which marks an important climate change or agricultural activity. This system has existed for thousands of years and has become an important part of the life and cultural heritage of the Chinese people. The 24 Solar Terms can play an important role in promoting the education of traditional culture among young people [1]. Digital technology has been updated and iterated, works have shifted from audio-visual presentation to stimulation of the five senses, and the expression of the 24 solar terms culture has been diversified. This puts forward new requirements for the education of solar term culture [2]. Li & Zhang [3] believe that educators integrating the 24 solar terms into teaching practice can not only promote common knowledge of solar terms, but also provide students with more opportunities to understand nature.

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Qu & Peng [4] compare and analyze similar products by using the Likert five point scale method, and with the design example of “Solar Term Baby”, it is feasible to jointly demonstrate the digital design of solar term cultural genes. This approach not only saves the cost of intangible cultural heritage protection, but also achieves good protection effects, providing new reference for the inheritance and protection of other intangible cultural heritage. Zheng [5] analyzed the specific process of dynamic font design practice for the “24 solar terms”, summarizing the font design concept and method. Hao [6] explores the application game design of cultural education from the perspective of user experience, explores the application game design strategies applicable to cultural education, and verifies the feasibility of application game design strategies through design practice.

The value of digital experience of cultural heritage mainly comes from the cultural heritage itself [7]. How to use digital means to expand new content, form new experiences, and play a new role for intangible cultural heritage is an important task that needs to be urgently solved in this research [8]. Developing games related to the 24 solar terms for students can not only promote and inherit the national intangible cultural heritage, but also effectively enhance the appeal of solar terms culture [9]. In games, it is necessary to balance traditional culture and modern design, develop through inheritance, and achieve true cultural inheritance [10].

1.2 Research Gaps

Firstly, many fields have conducted corresponding research on the 24 solar terms, but there is a relative lack of results that combine the educational methods of digital games with them. Secondly, current games related to cultural dissemination either lack interactive fun or are not closely related to culture itself, making them of little educational significance. Finally, we also need to explore the extent to which the combination of 24 solar terms culture and digital games can improve students’ interest in 24 solar terms culture, so as to obtain the effectiveness of an educational game in spreading twenty-four solar terms culture.

Therefore, more research is needed to combine the 24 solar terms with educational in order to spread this valuable intangible cultural heritage. The aim of this study is to provide students with interesting and impressive 24 solar term educational game designs. Explore the balance between interactivity and knowledge relevance. Enable users to develop a strong interest in the 24 solar terms during the interaction process and be willing to learn more about relevant knowledge. Finally, by investigating user experience, it was concluded whether educational games is effective in promoting the 24 solar terms culture.

2 Design and Development

2.1 Development Environment

The game is completed in UE4. Firstly, the landscape function is used to edit the terrain and add vegetation in Unreal Engine 4. The terrain is suitable for creating an atmosphere of small farmhouses in the mountains. And use network resources to build cabins, farmland, seats and other scene content in the scene. Then use animation blueprints and

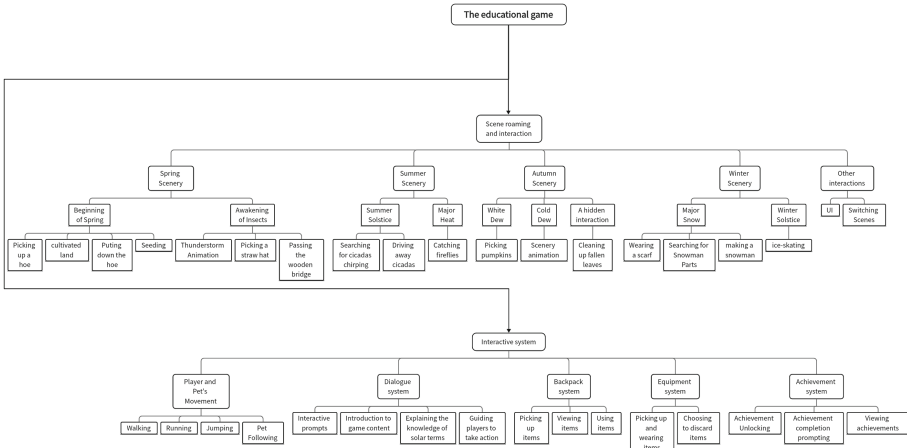


Fig. 1. System architecture diagram

blueprint classes to add motion control and animation effects to the characters. Then use the blueprint to add interactive parts in the scene, such as backpack system, dialogue system, scene change and farmland interaction, and use the Widget component to make the corresponding interface in the game. Finally, Unreal Engine 4 is used to test and debug the project.

2.2 Design Description

As shown in Fig. 1, the whole framework include 2 parts: 1) Scene roaming and interaction 2) Interaction system. These two parts constitute the entire interactive process of the game.

Make the following assumptions about the game content:

- 1) Players can smoothly complete the content and learn relevant knowledge according to the guidance.
- 2) Players can have fun during the game, watch corresponding interactive animations, and collect corresponding achievements.
- 3) Players can learn about the customs of the corresponding solar terms and cultural information such as ancient poetry through this game, reflecting the educational nature of the game.

2.3 Game Features Description

Figure 2 shows a portion of the interactive content in the game, where players can promote the game process through interaction. At the same time, the scene content will undergo certain changes.

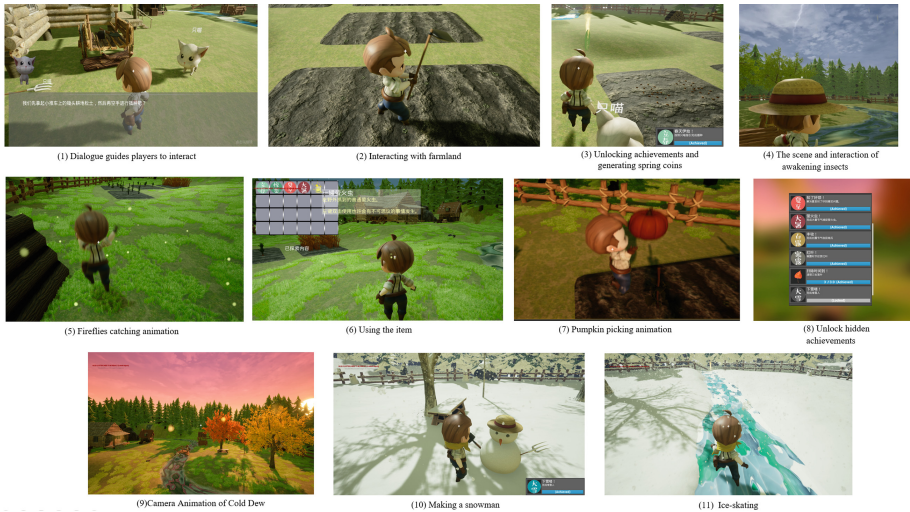


Fig. 2. Partial interactive content in the game

2.3.1 Spring Scenery

The player start in a cabin, and after leaving the cabin, they can have a conversation with a pet cat. As shown in Fig. 2 (1) and (2), after reaching the mission point, the dialogue will guide players to use hoes for plowing and sowing in Beginning of Spring. In Fig. 2 (3), after the interaction of each solar term is completed, the corresponding solar term coin will be obtained and the related achievements will be unlocked. Players can open their backpack to view coins, which will display poems and food introductions of the corresponding solar terms.

The subsequent interaction is the interaction of awakening of insects, and the scene will change accordingly. Awakening of Insects has the saying ‘spring thunder rings, all things grow’. At this point, there were tender shoots on the bare trees in the scene, and the river water also thawed. As shown in Fig. 2 (4), players need to watch a camera animation of thunderstorm, then return to the cabin, and switch scenes.

2.3.2 Summer Scenery

In summer scenery, when the player leaves the cabin, there will be a dialogue indicating that it is the Summer Solstice. The player is disturbed by the cicadas chirping at night, and needs to find the location of the cicadas based on the size of the sound and drive them away.

The next interaction is the interaction of the Great Heat, where beautiful fireflies can be seen on the night of the Great Heat. As shown in Fig. 2 (5) and (6), players can capture fireflies according to guidance and use items to surround them with special effects.

2.3.3 Autumn Scenery

Players starts in the autumn afternoon. As shown in Fig. 2 (7), according to the dialogue prompts, the White Dew solar term is when the pumpkin is ripe, and the player needs to go to the field to pick the pumpkin.

Another interaction is the camera animation interaction of the Cold Dew solar term. At this point, as shown in Fig. 2 (9), players can see the scene of red leaves falling in the sunset. Afterwards, as shown in Fig. 2 (8), players can also complete the hidden achievement of clearing fallen leaves.

2.3.4 Winter Scenery

In Great Snow, it's snowing heavily outside and players need to wear scarfs to keep warm, or they cannot go out. As shown in Fig. 2 (10), according to the guidance, players need to gather all the components of the snowman to complete a snowman.

The winter solstice is the coldest time of the year, hence the thickest ice surface. So, as shown in Fig. 2 (11), players can skate on the ice. Players will start from one side of the river and slide to the finish line. After completing the skating interaction, the game content ends.

3 Result

We randomly selected multiple students of different age groups to test the game, with a total of 20 students. The purpose of the test is to verify the educational function and fun experience of the solar term culture educational game based on this theoretical practice. After users have played all four seasons of interaction, the playability, educational effect, and dissemination effect of the application game are verified through a questionnaire.

Users explored and interacted in game scenarios based on in-game dialogue guidance. During this process, we provided guidance and recorded them when they meet difficulties, to verify the usability and fault tolerance of the game.

3.1 Questionnaire Investigation

The questionnaire is intended to understand students' evaluations of various aspects of this solar term education game. Students' attitudes toward those questions can be divided into five kinds, 'A' corresponds to strongly agree, 'B' corresponds to agree, 'C' corresponds to remain neutral, 'D' corresponds to disagree, and 'E' corresponds to strongly disagree. Three categories and nine questions are present in Table 1.

From the students' answers, we can figure out the following numbers in Table 2.

3.2 Data Analysis

The following information and Fig. 3 can be acquired from Tables 1 and 2.

It can be seen from Tables 1 and 2 and pie chart that the tested students have a high evaluation of the playability, educative nature, and user stickiness of this solar term education game. It is not difficult to analyze that 76.67% students believe that games

Table 1. Structure of questionnaire

| Aspects Number | Testing Aspects | Question Number | Questions |
|----------------|------------------|-----------------|--|
| 1 | Playability | 1 | I feel the fun and interactivity of the game |
| | | 2 | I feel the relationship between game content and solar term culture |
| | | 3 | I get a sense of achievement and satisfaction from the game |
| 2 | Educative Nature | 4 | I think the game design fits the cultural content of solar terms |
| | | 5 | I get relevant knowledge through the game |
| | | 6 | This game sparked my interest in solar term culture |
| 3 | User Stickiness | 7 | I will follow the updates of this game and be happy to participate in it |
| | | 8 | I am willing to recommend this game to friends around me |
| | | 9 | I prefer this educational game to traditional cultural promotion methods |

Table 2. The number students' answers in each testing aspect

| Aspects Number | Testing aspects | Percentage (%) | | | | |
|----------------|------------------|----------------|-------|-------|------|------|
| | | A | B | C | D | E |
| 1 | Playability | 41.67 | 35.00 | 16.67 | 6.67 | 0.00 |
| 2 | Educative Nature | 48.33 | 36.67 | 11.67 | 3.33 | 0.00 |
| 3 | User Stickiness | 48.33 | 36.67 | 15.00 | 0.00 | 0.00 |

have strong interactivity and are closely related to solar terms culture, allowing players to feel fun and a sense of achievement during the playing process. And 85% students believe that game content can be well linked to the culture related to solar terms, and they have learned some knowledge from it. In terms of user stickiness, students also gave high praise. They are willing to let more people know this educational game and are willing to continue participating in testing. For the ninth question, all students feel that this educational game is better for spreading solar term culture than traditional educational methods.

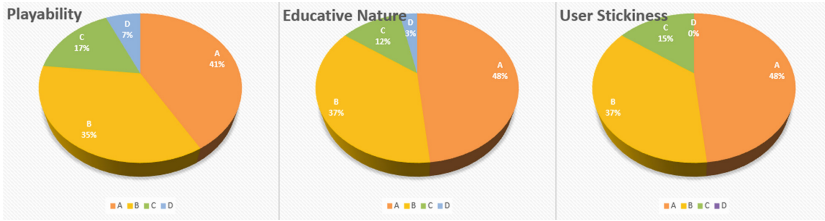


Fig. 3. Percentage pie chart of playfulness, educative nature, and user stickiness

Overall, the game is good in terms of playability, education, and user stickiness. But there are also some issues. 1) There may not be sufficient guidance in the game, resulting in some users not knowing what to do next after not carefully reading the game dialogue. 2) Compared to educational and user stickiness, game playability scores are lower. The reason may be that users lack freedom in the game.

4 Conclusion

This research successfully combines educational games with the 24 solar terms culture. Each interaction in the game corresponds to the corresponding knowledge of a solar term, making the game content closely related to solar term culture. Through the analysis of questionnaire survey results and data recorded in tests, students have high evaluations in terms of gameplay, education, user stickiness, etc. However, there is still room for improvement in game content and guidance.

The high evaluation of the tested students proves that this study has certain research significance. In the process of spreading and developing traditional culture, including the 24 solar terms, we must combine the things that target users like and are interested in with it, in order to achieve the goal of education through entertainment and better promote traditional Chinese culture.

The development of educational games in China is still in its infancy. How to truly convey cultural content to users through interesting game forms, and enable users to achieve a truly educational and entertaining game experience and dissemination is an important content of theoretical and practical research. We hope that this study can provide some ideas for future scholars.

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