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An Educational Virtual Reality Game from an Embodied Cognitive Perspective

-Take the Game "Poetry" as an Example

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Abstract: With the rapid development of virtual reality (VR) technology, it has become a trend to apply VR technology to assist teaching in the field of education. At present, the learning of traditional poetry is often in the form of book learning. The lack of physical and sensory interaction in the learning process leads to a lack of initiative and enthusiasm for learning, resulting in low learning efficiency. Based on this background, this paper develops a poetry learning game based on VR technology, which creates interactive scenarios based on the depiction of poems and allows users to learn poems in an immersive experience. Users can complete their poetry learning objectives by experiencing the game's plots and completing game tasks. Based on embodied cognition theory, the game applies the strong sense of presence and immersion of VR technology to enhance the interaction between the user's body and the poetry scene, thus improving the user's knowledge and understanding of the poetry, deepening their memory of the poetry and enabling them to learn in a more effective and interesting form. The game uses Cinema4D to design and model the poetry scenes and the game engine Unity to realize the interaction with the user. Through the study of the game scenes and user evaluation, the experimental results show that the game achieves the design purpose and has an application value.

Keywords: virtual reality, game, poetry, cognitive perspective

1. Introduction

VR educational games, as a kind of VR games, have been widely used in the field of educational teaching aids in colleges and universities, and are gradually becoming a research hotspot to promote teaching with interactive technology. The application of VR technology to teaching shows a trend of integration with multiple fields [1]. From the psychological perspective of embodied cognition, the immersive engagement of VR technology emphasizes a strong sense of presence and interactivity so that physical interaction activates mental activities and improves the quality of teaching and users' learning motivation. VR educational games are set to play a role in interactive education as a multi-sensory and participatory teaching method [2-4].

Current VR learning games are mostly presented with animated video effects, lacking interaction with the game scenes or characters, and users lack opportunities for further immersive learning. To

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address these issues, this paper proposes VR educational games from an embodied cognitive perspective, using the strong interactive and playable modes of VR technology to transform book learning into a more immersive experience. Guided by this theory, this thesis designs and develops a VR experiential game: Poetry, a VR educational game for learning poetry. The game enables an immersive learning experience that is both knowledgeable and enjoyable through virtual reality technology. The game uses Cinema4D for 3D modelling of the game scenes and characters and Unity as the game development engine. In the game, the user takes on the role of an explorer who can travel through time and space, retrieving the corresponding dynasty through a map and entering the scene of the poem they wish to study. The user discovers the meaning portrayed by the different verses in an immersive scenario that matches the picture depicted by the poem. At the same time, the user can communicate with the poets to understand their creative intentions; and trigger different quest points to complete the adventure.

2. The Game of Poetry

Poetry is a game that helps viewers to learn and explore the fascination of poetry. Players can engage in conversation with the ancients while surrounded by the stunning scenery portrayed in ancient poems. Through the immersive presentation and replication of poems, viewers are able to better comprehend culture and master the poems in a more pleasurable and efficient way. Poetry presents the tedious learning content in the form of an immersive interactive game, making the learning process both educational and entertaining. It makes students' multiple senses stimulated and achieves the purpose that mind, body and cognition work together for learning, thus improving students' learning efficiency.

2.1. VR Educational Game Innovation Based on Embodied Cognition Theory

2.1.1. Strong Sense of Experience and High User Involvement

Embodied cognition theory believes that cognition is the cognition of the body, including the brain, and is the product of the interaction between the body and the environment in the process of perception and action [2,5]. Guided by this theory, learning games that apply VR technology allow users to actively interact with immersive scenes, enhancing their bodily sensations. For example, by interacting with the images of the poems reproduced in the VR scenes, users achieve a deep impression visually; forming a physical memory of movement by touching the props in the virtual scenes or interacting with the characters; and feel different moods by feeling the different poetic moods and emotions expressed by the scenes and characters.

In this series of immersive experiences and interactive behaviors, the user's visual memory, physical movement and psychological feelings prompt the formation of a more systematic cognition, increasing the user's physical and mental involvement, making the learning process an immersive experience, highlighting the interaction between the user's physiological body senses and the game scenes increasing students' motivation to learn and making learning more effective [3,6].

2.1.2. Impressive Visual Scenarios

The game creates a virtual world of ancient poetry through VR technology. VR-based technology creates embodied virtual worlds in which the imagination and the physiological organism participate together. In this world, the user acquires knowledge in a virtual immersive world created by VR technology, rather than through books and static texts in the traditional learning paths [7]. Through interaction with touch, hearing and vision, users experience the world of books in a holistic and hands-on way and gain relevant knowledge. The immersive experience of Poetry is

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more direct and effective, impressing players with its visual impact and depictions in the story, enabling users to better learn and understand the profound meaning of poetry and inherit culture.

2.2. Mode Setting

The core setting of this game is a grand, immersive traversal immersion experience. Users can immerse themselves in the majestic images depicted in the poems and have conversations with the poet, in which they understand the poet's mood and creative intentions. The game is categorised into modes for different groups of people, namely Learning Mode and Creation Mode (As shown in Figure 1).

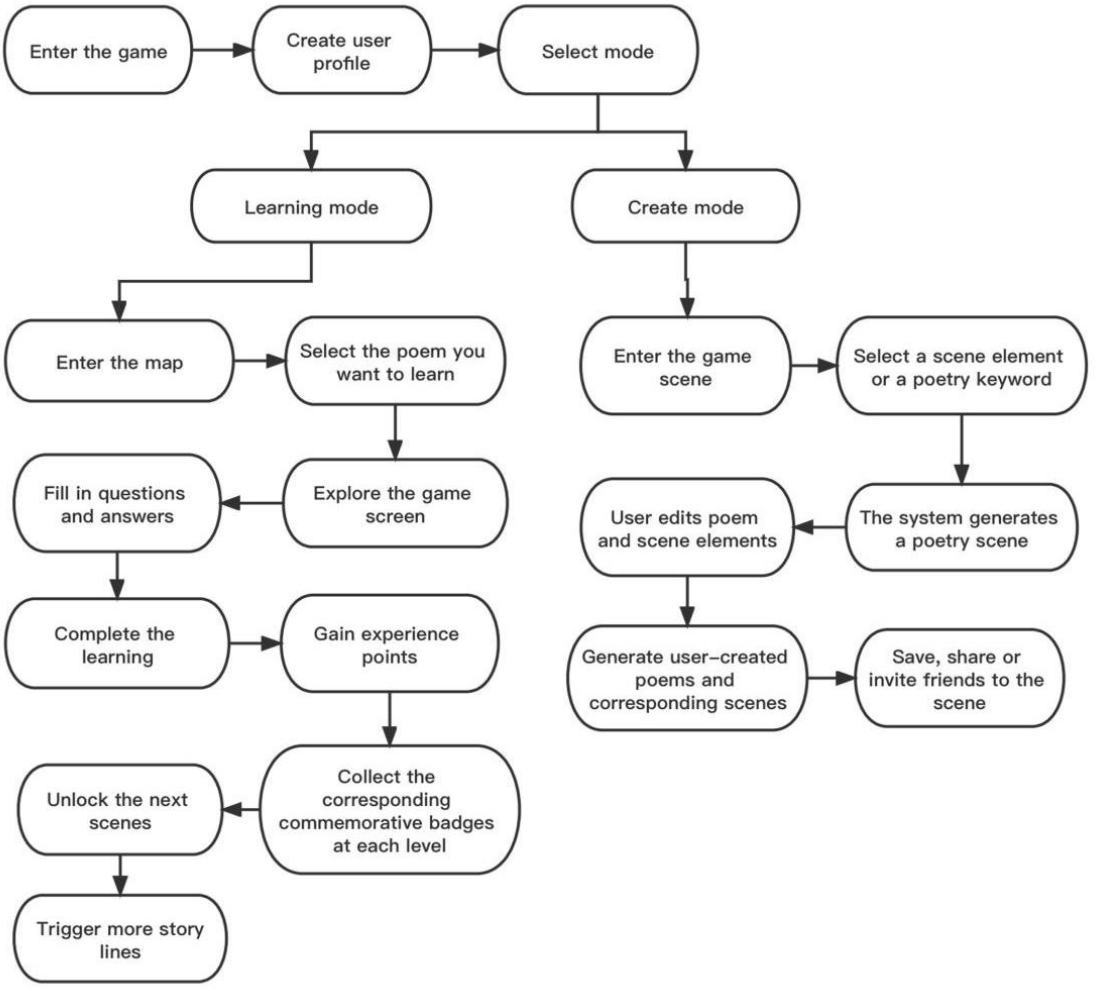

Figure 1: Logic lines of the game's modes.

2.2.1. Learning Mode

For students or learner users who have a need to learn and memorize ancient poetry, the learning mode will set up ancient poetry memorization and ancient poetry fill-in-the-blank exercises at different level starting points to consolidate the learning content and improve the effectiveness of learning. For the logic lines, users memories and learn the poems by filling in questions and answers, and collect the corresponding commemorative badges at each level after completing the learning; unlock the next poem with the commemorative badges and gain experience points. The more experience points users have, the more story lines users can trigger.

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Users will be able to select poems and enter the game world through a story line of poets or dynasties. Players will be able to choose their character's costume. Once inside the story world of the poems, players will be able to interact aurally and visually with the ancient environment and explore the world of the poems, experiencing the emotions conveyed by the poems and having conversations with the characters and intentions involved in the poems. Questions and poetry fill-in-the-blank tests (as shown in Figure 2) are set at chapter level settings, such as the game's character dialogue and the triggering of environmental levels, in order to reach the function of testing and refreshing the memory. The game copy includes exploring in different era backgrounds, allowing for tea tasting, poetry fighting and poetry pairing with the ancients to experience the elegance of ancient literati. The VR mode of poetry learning unifies the senses and cognition to better understand and remember poetry and pass on culture.

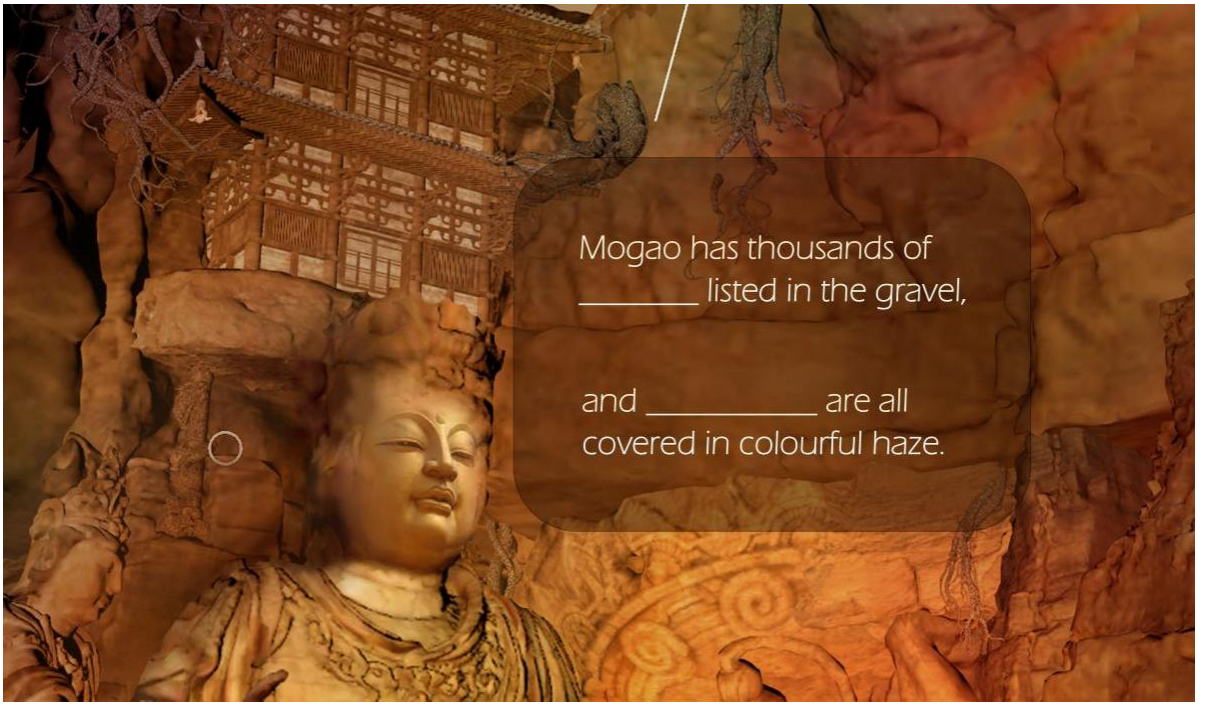

Figure 2: Poetry fill-in-the-blank tests.

2.2.2. Creation Mode

For poetry lovers or players, the creation mode will make changes at the game map, which will be presented in the form of a random adventure map with elements chosen by the user, generating a visual experience where words are transformed into an immersive space created by the user (As shown in Figure 3).

Users are able to enter the game for non-learning purposes. In creation mode, players will have the opportunity to create their own poetry worlds, where there are no restrictions on poetry creation in terms of era and context, no specified topics, and players can improvise their own poems by choosing or proposing certain intentions. Players can also adjust the world elements and interact with the game elements. Players can collect each poem they create and walk through the poetry world they have created, or invite other players to create and communicate with each other, in order to promote culture and let more people understand the meaning of the story and inherit the creation of poetry.

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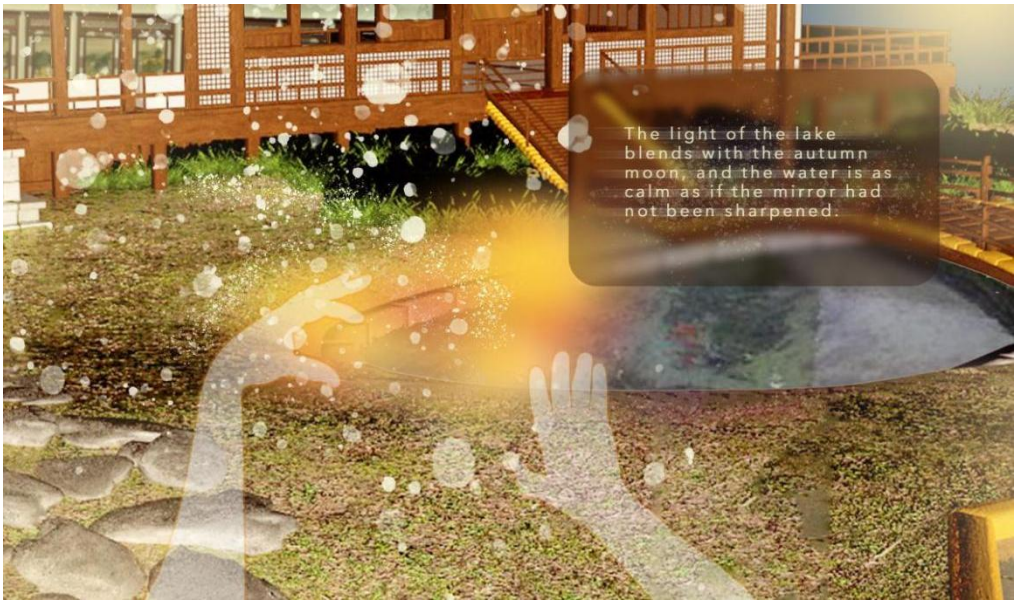

Figure 3: Creation mode.

2.3. Game Scene Design

2.3.1. Recreating the Poetry Scene

In the VR scenes of the game, users will see scenes that are based on the content of the poems, visualizing the mood of the verses. For example, the poem 'Dunhuang Grottoes' states "Mogao has thousands of caves lined up in the sand and gravel, and the cliffs are covered in colourful haze." The glorious images of the Dunhuang Grottoes were modelled in Cinema4D, using the huge stone statues and frescoes in the grottoes, including their brownish-yellow stone material, to convey a sense of age and grandeur (As shown in Figure 4).

Figure 4: Scene of the Dunhuang caves.

The choice of materials for the statues incorporates colors commonly used in grottoes, such as brown and yellow, and the colors on the statues in the grotto are still lustrous through the ages. When the user touches or approaches the statues, the corresponding poems describing the statues are displayed for verses learning (as shown in Figure 5). The lighting settings are set sidelight according to the scene described in the poem, and reflective materials are added to make the cliff

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walls of the grotto shimmer with haze. This allows the user to immerse themselves in the mood of the poem.

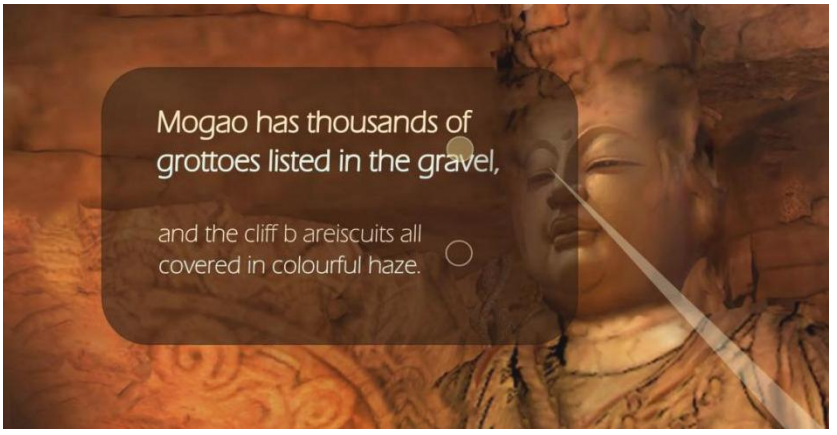

Figure 5: Scene of verses learning.

2.3.2. Level Settings

In the learning mode of the game, when the user walks to the corresponding location, the scene will trigger the display and recitation of the poem, and the background and author information of the poem can be viewed. The trigger points for the levels are implemented using Unity components, and each time the user completes a level after learning a poem, they will receive a learning medal and unlock more scenes.

2.4. Character Design

The game's characters are divided into user Characters and non-player characters, which are styled as simulated human versions of the characters, with a 1:7 head-to-body ratio, close to realistic proportions. The user character is designed with the user in mind and can be freely chosen. The user is free to choose the character's head hairstyle, facial features, clothing and accessories according to their preference. Non-Player Characters are usually poetry creators or characters depicted in poems, who will be set up in the game map with different looks, costumes and props according to the background of different dynasties, recreating the descriptions in the poems and creating dialogue lines based on their personality traits (As shown in Figure 6).

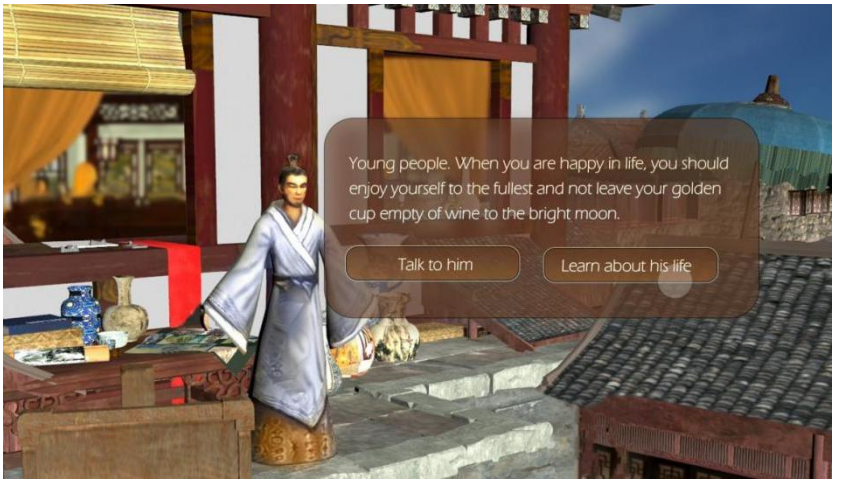

Figure 6: Character interaction.

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2.5. Model Construction

2.5.1. Scene Design and Construction

The models of buildings, characters and props in the scenes are based on in-depth analysis of the image characteristics of the objects, based on the design reference drawings, using the tools of polygon modelling of Cinema4D software such as “extrusion”, “welding”, “tangent”, “connection” and “bridging” for modelling, including spreading UV, mapping and rendering baking [3, 8]. In addition, the model is drawn and edited with the appropriate material mapping to match the image characteristics and colour tones of the model shape, depending on the different characteristics of the object in terms of special visual effects. For example, the creation of a character model is based on a full understanding of the structure of each part of the character. The head, body, limbs and other parts of the character are modelled, textured with texture, such as hair length, density, clothing texture, etc. Finally, materials and lighting are created and baked, and imported into the Unity engine as FBX files [9].

To build the scenes, Poetry combined the setting of the poem with the author’s dynasty to create the architectural style and props for the scenes. The overall scene was created using the Unity terrain system to draw the terrain and create and add materials. The coordinates of the scenes in the game, such as the palace wall buildings, pavilions, shops and stone gates, are determined with reference to the game terrain design map, and the cube is constructed to plan the subdivision of the scene space. In addition, lighting was created and C# scripting was used to give the scene a photo-realistic rendering, interacting with the characters and enabling props to interact with the natural environment.

The cube is built to plan the subdivision of the scene space. The coordinates of the game’s scenes, such as the pavilions, stores, and stone gates, are decided with reference to the terrain design map. In order to give the scene a photo-realistic rendering, the game uses different lighting to built environment. During development, C# scripting was used in Unity to implement interaction with characters and interaction of items with their surroundings.

2.5.2. Character Animation Design

Character animation in the game involves two main categories, the first category is the animation of the scenes depicted in the poetry scenes, for example: shining grottoes, rushing rivers, trees fluttering in the wind, blooming flowers, etc. The second category is the characters that appear in the scenes, such as the character storylines and character movements depicted in the poems, such as drinking, looking up at the moon, riding a horse, etc. The animation of scenes and characters in the game is based on the models created. The realistic and fluid animations in the game scenes are created through skeleton creation, skinning, weight drawing, controller binding and keyframe animation and curve editor in Cinema4D software.

The process is to create and configure the Avatar, Animator Controller and Blend Tress for the character by exporting the FBX file containing the animation information through Cinema4D and importing it into Unity, thus laying the foundation for the character animation to play and start [4]. For character animation triggering and interaction, this is mainly achieved through C# scripting and the UI interface.

2.5.3. Interaction Interface Design

The UI interface is the core of human-computer interaction in VR games, including user interface design, interface hierarchy and functional correspondence. The interactive interface design of Poetry mainly includes the main interface, selection dialogues, guide arrows, points system, etc.

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[4,10-12] It allows players to switch between scenes, select game modes, introduce poems, trigger levels, and select character dialogues with the help of a VR headset, VR hand perch, VR silver mirror and peripherals such as a keyboard and mouse. The interactive interface uses the Unity system, based on the UI interface layout and visual aesthetics design, with the help of C# scripting to achieve the corresponding dynamic interaction effects.

For example, the design of the dialogue box, which is the interface for interaction between the user and the player, plays a role in advancing the development of the storyline and interaction with the player. The first step was to use Photoshop software to design and draw the dialog box and button set-up. The second step was to create the controls for the Unity system and drag the created graphics file into the Source Image, using C# to implement the dialog box size change and effect. Then the dialog box can appear in the scene and complete the interaction effect with the user.

3. Results & Discussion

The game was tested on four dimensions: immersion, user involvement, learning effect and attraction, guided by embodied cognition theory and the application of VR technology. The test required the evaluators to rate the game based on the above four dimensions after understanding and experiencing the game scenario and gameplay. A total of 52 valid ratings were collected for the test (as Table 1).

Table 1: Statistics on rater evaluation scores.

Immersive Experience Score	Immersion	User involvement	Learning effect	Attraction
>90	38(persons)	42(persons)	34(persons)	32(persons)
>75	10(persons)	8(persons)	12(persons)	17(persons)
<75	2(persons)	4(persons)	4(persons)	5(persons)

In the evaluation, 38 reviewers gave the dimension of immersion a score of 90 or above, accounting for 73.07% of the total, indicating that the game provides users with a good sense of immersion and presence. In addition, in the dimension of user engagement, 42 users gave a score of 90 or above, accounting for 80.76% of the total, which is also the highest average score among the four indicators. The test shows that users learning poetry in the VR environment has led to more interaction of the physical senses, increasing the sense of involvement and independent learning, and a strong sense of engagement, which is conducive to active participation of users in learning. With 48 and 49 raters scoring 75 or above for the two indicators of learning efficiency and attractiveness, accounting for 92.30% and 94.23% of the total number of raters respectively, the impressive visualization of poetry in the game scenes enables users to better remember the poetry content and learn efficiently. Furthermore, the gameplay and visual experience added to the enjoyment of learning and was more engaging than traditional text and book texts. Therefore, the evaluation results show that the game has achieved its design purpose and has some practical value.

During the test, users were able to reconstruct their imagination of the poetry images through the accurate reproduction of the poetry scenes in the VR scenes. The application of VR technology allows users to immerse themselves in the experience of learning poetry based on both physical and cognitive engagement, facilitating their learning efficiency. Through the guidance of embodied cognitive theory, this game incorporates sensory and physical interaction, highlighting the interaction between the user's body and the immersive scene through the application of VR technology, and creating an educational scene of poetry based on this, so that the user is physically involved in the experience while stimulating the cognitive system to participate. As a consequence, the cognitive process of learning in this process produces a more complete and clear memory,

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helping users to better understand, remember and learn the poems. This process exemplifies how learning can be enhanced when embodied cognitive theory is combined with the application of VR technology.

Compared to VR poetry education games, the traditional poetry learning model lacks physical interaction, which leads to a lack of clarity in students' perception of poetry. Students are often passive recipients of knowledge rather than active explorers, and as a result, poetry is often seen as a difficult area of learning in language learning. However, through the immersive experience of VR, boring text learning is transformed into a fun learning experience, making it easier for students to accept and immerse themselves in. Poetry integrates the interaction of the body, feelings and scenes through user-led exploration-based learning, allowing users to understand the knowledge as they engage while gaining an immersive and interactive learning experience, which shows that the use of VR games allows users to have a more intuitive feel and enjoyable experience of the course content.

4. Conclusion

This paper examines the practical application of VR games in education in the context of embodied cognition. Taking the VR game Poetry as an example, this paper makes teaching and learning more effective through immersive learning, where students satisfy the dual needs of exploration and learning through VR learning games and acquire knowledge in a positive and active emotional state. The application of software such as 3D modelling and game engines enables the implementation of interactive educational games based on embodied cognitive theory. Based on game analysis and users' tests, the study shows that VR educational games guided by embodied cognition do have a positive impact on users' memory skills and emotional cognition. This suggests that the application of VR learning games can increase students' motivation, enthusiasm and overall emotion, and play a rather positive role in their learning process.

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