

# An immersive game of simulated visually impaired

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## Abstract

**INTRODUCTION:** "Inverse light" is the experience of visually impaired people an immersive gaming experience, reducing the blind of the difficulties in life and study, etc., to bring players to experience the real life scene, the hearing, sight, touch, fully integrated into the game, let the players from the Angle of view of the blind, rational view of the nowadays social existence of accessibility issues, It also analyses several important issues, such as fun, playability, education in games, etc. This paper will elaborate the connotation of educational games and gamified learning, the source of creativity, and the design and implementation of games.

**OBJECTIVES:** In order to raise the public's attention to the visually impaired people and strengthen quality education, mobile games are combined with the inconveniences that the visually impaired people encounter in life to arouse the players' thinking and call on people to be more patient and helpful to the visually impaired.

**METHODS:** This game is mainly based on the black screen effect. In the case of limited vision, the direction is judged by clicking, holding down, sliding and other keys as well as the background sound effect, so as to bypass the obstacles. Finally, through the level, the background and animation in the game are designed with Photoshop, and the modeling is completed with 3DMAX. Microsoft Visual Studio was used to write C# scripts, and Unity was used for scene construction and overall coordination.

**RESULTS:** The experiment proves that the game can analyse the current situation of quality education very well and combine quality education with games. The system framework of the game has clear logic, moderate operation difficulty, and appropriate sounds are used to simulate visually impaired people, which increases the immersive sense of the game. At the same time, the problem of boring game and easy loss of players is solved, and the win-win effect of education and playability of the game is realized.

**CONCLUSION:** "Inverse light" game from the design ideas, game development framework, difficulty and other aspects of the analysis, has a very good reflection, and the game interface design is exquisite, has a certain level of art, can meet the experience of visually impaired people's feelings of the original intention of game development.

**Keywords:** Educational games, Visually impaired, Immersion, Interactive, Unity 3D

Received on 20 May 2021, accepted on 27 June 2021, published on 01 July 2021

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doi: 10.4108/eai.1-7-2021.170254

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## 1. Background

In recent years, with the transformation and upgrading of people's educational ideas, a variety of educational games have emerged in an endless stream[1]. In the era of knowledge explosion, people receive knowledge through various channels every day. More and more people gamify knowledge in order to reduce the pressure of study, so as to achieve the effect of "teaching through entertainment"[2].

Affected by the epidemic, Internet + cultural consumption has risen against the trend, boost the social recognition of cloud game has jumped. In recent years, many games are endowed with cultural heritage, recreation, public welfare aspects of the new dimensions of the new idea, game also get rid of "demonised" stigma began a new transformation toward "multi-function products". Data show that with the opening of the national game board number approval, the future is expected to further expand the user scale. At the same time, moral education is also an essential way of education in society. Along with the development of human society, the field of education has gradually undergone great innovation.

The application of "Internet +" in the field of education has become more and more widespread, which has changed parents' misunderstanding and rejection of games. Through the demand analysis, market research, the existing functional game industry and traditional industry, we found that many scholars at home and abroad with the game, with the help of workers on the market there is part of the visual obstacle group theme of the game, but its main body design is the materialization of the abstract of visual impairment of people, pay attention to the logical design of the game, And the content is generally the same, resulting in low resistance to play. In view of this situation, our team started to design and develop the game " inverse light", aiming to solve the problems of existing functional games, such as low fun, low playability, the same fantasy story of fighting monsters, long and weak functional feedback, and lack of educational significance.

## 2. Source of inspiration

According to the statistics of the national authority, China is the country with the largest number of blind people in the world. Transportation for the blind is a livelihood issue that cannot be ignored and has always been highly concerned by the government. During the two sessions in 2021, Premier Li Keqiang pointed out in the government work report that the welfare system for helping the disabled will be improved, and the quality of rehabilitation services for the disabled will be improved the need for the environment is becoming increasingly urgent. At the same time, "building morality and cultivating people" is the fundamental task of education, but now society often pays more attention to intellectual education, focusing on achievements and scores, ignoring the importance of moral education. Nowadays, moral education in our country is still developing and improving, gamified learning is also a good choice.

In view of this, we make a bold attempt to combine games with education. Through fun and stories, we teach children to develop compassion and empathy from an early age, develop good habits of helping others, and improve their own quality, so that children can feel the inconvenience of the visually impaired traveling from an early age. It is because the infrastructure is not perfect and we in reality to their neglect and wrong behavior to bring them, thus playing the role of enlightenment education, call for attention to the construction of visually impaired people and barrier-free facilities. Through this game, we hope that in the future, they will provide better security and support for the disabled in the construction of society.

## 3. Connotation of educational games and gamified learning

### 3.1 Education games

The study of educational games originated in the United States in the 1980s, but up to now the definition of educational games has not been unified[3]. However, with the development of the Internet, education is gradually combined with information technology, and educational games have become one of the hot research issues in the field of education. The United States as the representative of the industry believes that educational games is a serious game, is specifically aimed at the development of educational purposes of the game, with educational and entertainment characteristics of equal importance[4]. The aim is to complete the product realization of the education process through the way of games, so as to realize the new dimension concepts of games, such as teaching through fun and cultural inheritance. A well-designed educational game APP can arouse players' interest in learning and make them feel happy, so that they can learn imperceptibly during "playing"[5]. For example, In light Entertainment in Canada is well received by schools and educational institutions for its rich game content, mature game design and diverse game types, and it has been applied to many subjects such as mathematics and English at present[6]. As a carrier, it can increase the training of people's knowledge and skills, integrate education into games, and enable learners to achieve the best learning effect in a most natural state [7].

### 3.2 Game learning

Gamified learning refers to learning in a gamified way. Games are often accompanied by intense, pleasant, exciting and other experiences, so that players can have immersive experience[8]. The emergence of information network, to some extent, draws on traditional ways of information transmission [9]. Knowledge imparts knowledge and skills to students in the form of games in teaching activities, while students learn invisibility in a relaxed and happy atmosphere by challenging game levels and completing tasks in gamified forms[10]. That motivates them to keep playing. Gamified learning refers to the process of integrating educational games into teaching or learning activities so that learners can acquire knowledge and cultivate their abilities in relaxed, pleasant and active activities[11]. With the deep transformation of education, gamified learning has become an innovative learning method to stimulate students' learning motivation and improve the quality of education[12]. It is helpful to cultivate students' creativity and collaboration[13]and improve students' thinking ability[14].

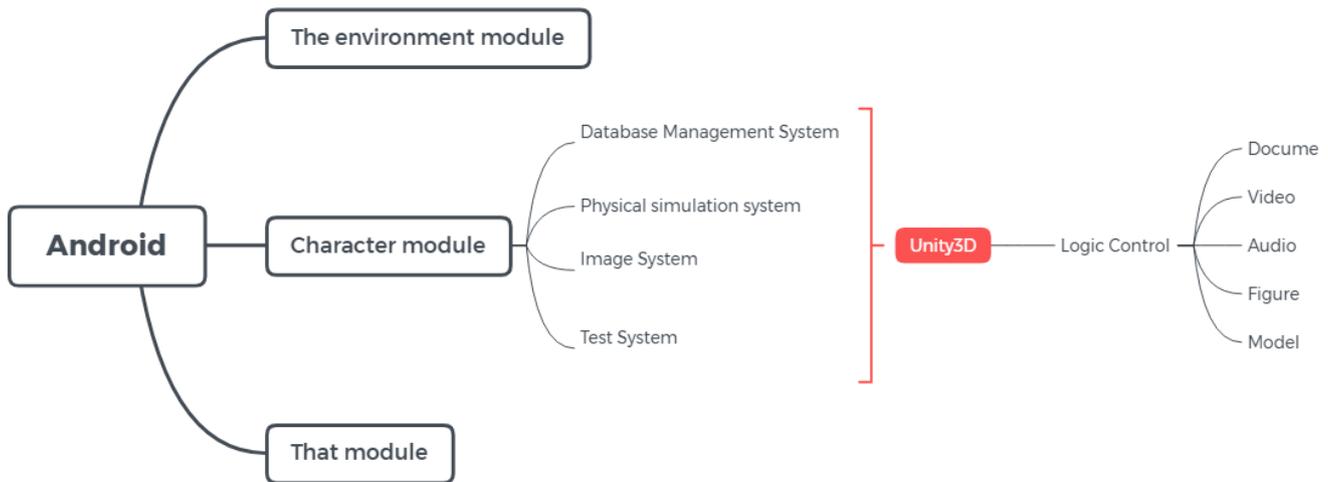
## 4. Connotation of educational games and gamified learning

### 4.1 System development framework

#### 4.1.1 Frame structures

This game supports the use of smart phones and tablet computers and other intelligent terminals. The specific

frame diagram is shown in Figure 1 .

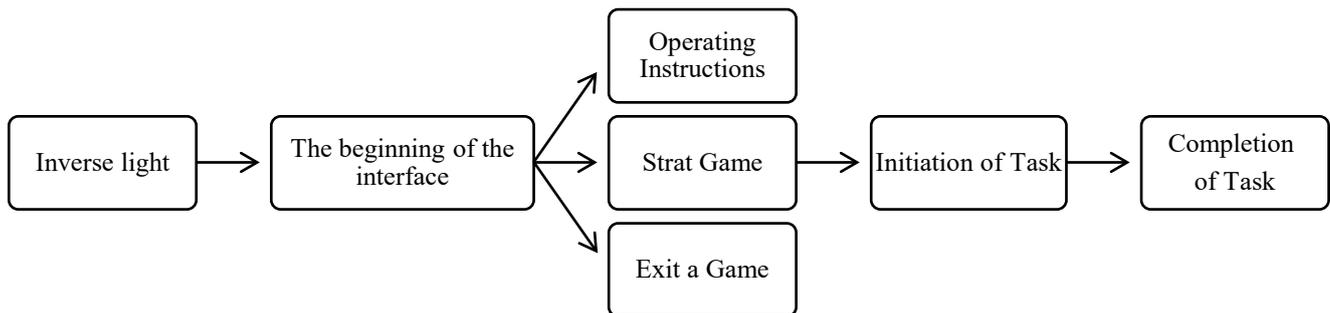


**Figure 1. System frame diagram**

The lowest layer of the framework is the data layer of documents, videos, audio, pictures, models, etc. Logical control is written through Unity3D engine and integrated into data management system, physical

simulation system, image system and test system. The top layer consists of environment module, character module and description module as the display layer.

The level flow of the game is shown in Figure 2.



**Figure 2. Level Flow Chart**

Players enter the game, understand the current situation of the visually impaired people, and complete the corresponding levels from easy to difficult according to the prompts and audio feedback. During the process,

#### 4.1.2 Environment modeling

According to the written story script, model or modify the models required in the scene, such as rooms, bicycles, blind roads, traffic lights, tables, trash cans and other related models required by the level. The modeling software used is 3DS Max. The modeling efficiency of 3DS Max is clearer than that of SMART 3D software, with more prominent details and better visual effect. The production of models required in the game is mainly divided into three aspects:

- (i) Using standard basic geometry combination to make simple models, such as boards, rooms, etc.;
- (ii) It is necessary to combine and deform geometry and change the corresponding joint points of geometry for basic modeling, such as traffic lights and desks, etc.;

the multi-sensory experience simulates the perspective of the visually impaired people, and finally helps the protagonist to successfully complete the task.

- (iii) Map modeling for the model. The object model requires clear details, such as blind roads, trash cans, bicycles, etc. The model material uses Photoshop to handle the image texture or the default texture.

In the process of modeling, the optimization of the model will directly affect the running efficiency of the game rendering burden[15]. The commonly used optimization methods are to reduce Boolean operation, avoid mixing triangular surface modeling with quadrangle surface modeling, delete redundant surfaces, modify wiring and attach models. Through optimization, the rendering speed of the model will be significantly improved[16].

The specific modeling process is shown in Figure 3.

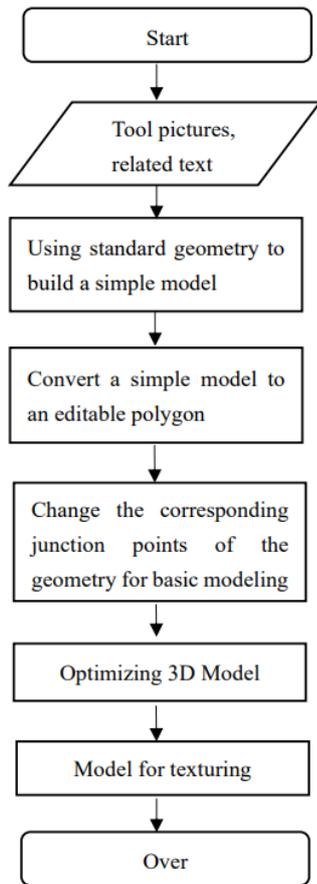


Figure 3. Modeling process

#### 4.1.3 Model import and scene construction

Import the FBX model exported in 3DS Max into the Asset folder of Unity3D, and the software will automatically recognize the imported model[17]. Add planes and build scenes in Unity3D, thus creating a relatively real virtual environment and increasing players' investment [18].

### 4.2 Overall design of game interface

The design of the game should meet certain psychological needs of the players to design the rules and environment [19]. In order to achieve a natural and good human-computer interaction experience effect and bring users immersive game feeling, the game interface design is divided into three types: the start interface, the game interface, the game end interface. Here is a detailed explanation:

### 4.3 Detailed design of game interface

#### 4.3.1 Start the interface design

The game starts with an original poster featuring a close-up of the heroine's face. Eyes are the source of light, and when a blind man loses them, he loses the ability to see the world. Game character design can not rely on

unconstrained imagination, in order to show a sense of reality, reflect a high degree of reality [20]. The beginning of the game interface focuses on depicting the protagonist "Ado" character image, eyeball is a girl bound by the rope, meaning that the action power of the people who lose the light is limited. The background is a dark pattern with light spots, the whole is a bit dark, and the red ribbon on the hair brings the only life to the picture. As shown in Figure 4.



Figure 4. Start interface design

#### 4.3.2 Interface design in games

The black and white tones used in the homepage image give people a feeling of depression and suffocation as a whole. Simulate the perspective of the blind, blurry and without color. The girl used to be a dancer, wearing a ballet costume, sitting on the floor of the dance room, lacing her dance shoes carefully. In the mirror behind her is the silhouette of her once dancing. The painting method with no details but outlines is in sharp contrast with the complicated details portrayed in the front, which makes people think about it.

The function key of the game is displayed in this interface, and the introduction of the game is shown in the mirror. Click to view the gameplay and background introduction of the game. The gear in the upper right corner is the game setting button, which can be clicked to turn off the music and adjust the brightness of the screen. On the left curtain is the game's logo "Inverse light", and in the top left corner is the volume button, which can be adjusted. As shown in Figure 5.

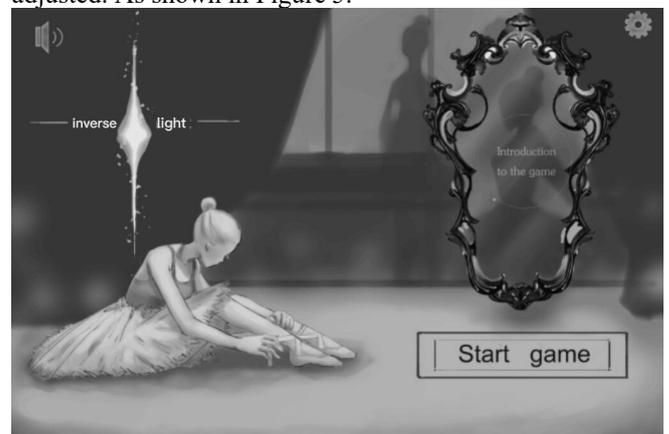


Figure 5. The in-game interface

### 4.3.3 Design of end-game interface

The end of the game interface is designed as a animation format, which will be automatically played after the game is finished, in order to sublimate the meaning of the work. Game art style is the visual appearance of the game product, which determines the most intuitive visual feeling the game gives to the player, and it is the entrance to the game world where the player really begins to feel immersive [21]. In order to make the game art style in line with the original design of the game product, the end of the game interface style is clean and simple. The main element of the interface is the game's heroine, a little black man. The heroine is designed with short hair and a loose dress, which makes the game's target audience feel intimate. Little Negro represents the anonymous warm-hearted people in this society.

The average gamer likes games with good graphics, because visuals are as good as even the best storylines [22]. At the beginning, the color of the game interface is only black, white and gray. The heroine is in the center of the screen, surrounded by only a few little black people. Each little black person in the screen has a heart, which is connected with the heroine's heart through lines. In the following picture, more and more little black people appear around the heroine, and the picture gradually becomes colorful and warm. In this way, it reflects the change of the heroine's state of mind after being helped by more and more people in the society, and appeals to people to care for the visually impaired. As shown in Figure 6.

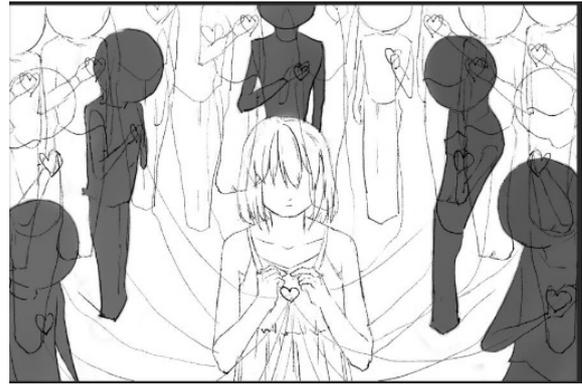
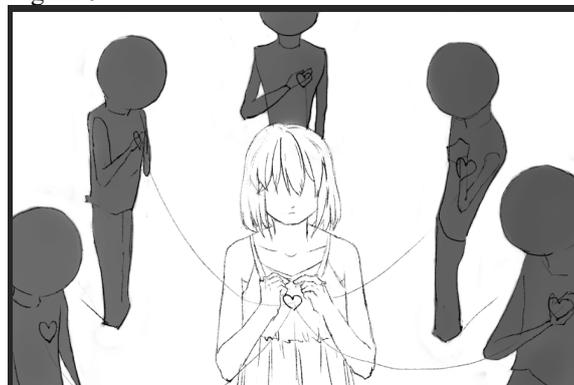


Figure 6. The end-game screen

## 4.4 Core technologies

### 4.4.1 Protagonist moving

The movement of the character in this game is to create a new script role on the first-person virtual character as a control character movement script, set a movement speed move speed and set an offset speed rotate Speed on the inspector interface. Use the Move Joystick (Input. Get Touch (touch Index). position); method to monitor the direction of the user's finger movement. If the dynamic joystick is controlled to slide up, trigger the statement transform.Rotate (Vector3.up × rotate Speed, Space. Self) method to dynamically remotely sense the lower left The angle shall prevail, determine the offset of the relative moving position, and call transform.Translate (new Vector3(moveVec.x,0,moveVec.y) × move Speed, Space. Self) method to calculate the movement of the character in the scene by creating a Vector3 object Position; can make the first person move in the specified direction, so as to complete the movement control of the first person character[23]. Part of the code is as follows:



```

Begin
touchIndex=0
void Update(){
  if touchLeft == true
  {
    transform.Rotate(Vector3.down*rotateSpeed,Space.Self);
  }
  if touchRight == true
  {
    transform.Rotate(Vector3.up*rotateSpeed,Space.Self)
  }
  Call CheckJoystick ();
}
void CheckJoystick()
{
  If joystickTouchDown

```

```

{
  joystickTouchDown = false
  touchIndex=i; break
}
if joystickTouching == true {
  MoveJoystick(Input.mousePosition)
  MoveJoystick(Input.GetTouch(touchIndex).position)
  resetJoystick () method
}
}
}

```

**4.4.2 Viewing angle trigger and conversion**

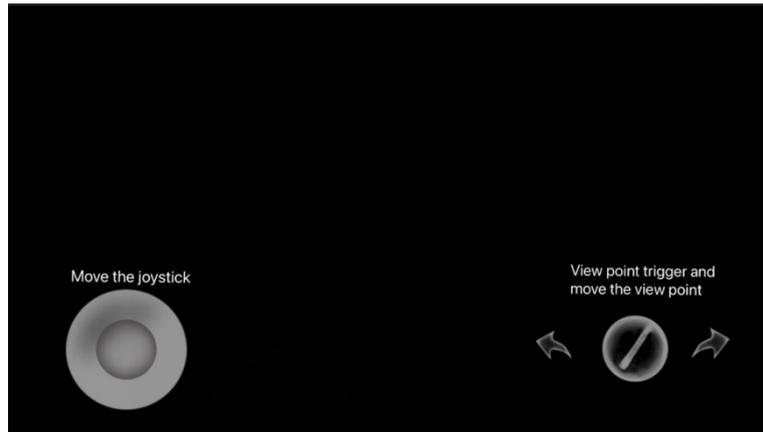
In the game scene, the user can click the cane button at the bottom right of the game scene and move the angle of view key left and right to trigger the visibility and direction of the angle of view. Create a new test. cs script and use the Camera. Set Replacement Shader() method in the test. cs script to use a shader globally to process all vertex and fragment. Use the Move far Clip Plane() method to control the direction of the perspective, and use the Test Click() method to control The perspective

conversion method and the visual visibility method in the Move far Clip Plane() method. Mount the test. cs code to the cane key button. When the cane key button is clicked, a certain visible range can be triggered, and when the view angle conversion key button is clicked, the angle of view will rotate with the click of the conversion key, thereby achieving. The angle of view conversion is shown in Figure 7. Part of the code for the viewing angle trigger and viewing angle switch key is as follows:

```

Begin
void OnValidate(){
  Shader.SetGlobalColor(color)
}
void OnEnable(){
  GetComponent<camera>().SetReplacementShader
(ReplacementShader,"");</camera>
}
void OnDisable(){
  GetComponent<camera>().ResetReplacementShader();</camera>
}
Create TestClick () {
  if movefarClipPlane !=null
  Call the stopCoroutine ()
  Call MovefarClipPlane () = MovefarClipPlane
  Start co-forming method startCoroutine (moveFarClipPlane)
}
IEnumerator MovefarClipPlane(){
  CetComponent<camera>().farClipPlane==0;</camera>
  while GetComponent<camera>().farClipPlane
< maxRange</camera>{}
  yiled return 0
}
}
Create TestClick2 (){
  StartCoroutine(MovefarClipPlane())
}
}

```



**Figure 7.** Perspective triggering and moving perspective diagram

#### 4.4.3 Sound control

Music in the game can not only foil the atmosphere of the game scene, but more importantly, it can promote the development of the story, deepen the theme of the game, and play an important role in the overall game interaction [24]. In this game, you can first create a script and mount it on the game camera with the audio device added. Set the script to Play when waking up, and call the audio. play

() method to automatically Play the specified background music when the player enters the game scene. But for the game character collision to some objects (such as: barricade, table, etc.) call on Collision Enter () method to determine whether the collision, and then call audio. play () method to achieve the specified audio playback. Part of the code is shown below:

```

Begin
Using On Collision Enter (Collision Collision)
    If (a collision. The game Object. Name == "Cube")
        Audio Source adion = Get Component<audio source>()</audio source>
        Adion calls Play() to Play the audio
        Background output "wo beng zhang!"
        if(collision. Game Object. name. Equals("Cube"))
Create On Collisin Exit (Collision Collision)
if(collision. Game Object. name. Equals("Cube")

```

#### 4.4.4 Text display

Text display is an important way to guide beginners and convey information in games. First, create a new script Text Type. cs to create a dynamic typewriter effect for the game. Set the typing time and speed in the script Text Type. cs, get the Text component for adding the Text that

needs to be displayed, create the on Start Writer () method and the on Finish () method. The on Start Writer () method starts typing and refreshes the display, while the on Finish () method ends typing and initializes the data. Part of the code looks like this:

```

Begin
void Start()
    The timer timer = 0
    The text displays is active== true
    Display speed chars Per Second = Mathf. max (0.05f,charsPerSecond)
    My Text== get Component <text>()</text>
Save the text words= matext. text

```

## 5. Discussions

This game realizes the combination of quality education for special groups and games, which has not yet been innovatively combined in the existing game market. On the basis of 3D game development, the team develops games based on the needs of special groups and the current situation of quality education for special groups. Most games at home and abroad are developed for special groups, or simply develop an experience game.

The game is designed to provide an immersive experience for the player. Comparing the third person perspective with the first person perspective, it is concluded that the first person perspective is more suitable for the player to engage in the game. The game page is full of black, bringing a more real experience of visually impaired people[25]. The game developed based on Unity3D can integrate children's English education into the game and combine teaching with fun, so that parents can make full use of spare time to cultivate children's interest in English learning. But the reality is that these games don't start with curiosity, and are more of a forced way to build a player base. The unique

perspective and gameplay of the game studied in this project can stimulate the curiosity of users and enable them to actively use this game. The main gameplay of the developed game is to answer questions of historical knowledge points with progressive difficulty levels. The beautiful screen enables players to consolidate what they have learned in the game, which is more attractive than traditional history teaching. But the game has low playability. The game of this project adds a lot of interaction design in the aspect of game playability, and makes players willing to continue the game through good interaction functions. The research points out that educational games in China tend to be simple and courseware based, and it is concluded that educational games should not be designed with too much emphasis on either game or education, which will make educational games lose their significance. Instead, educational games and games should be combined organically.

## 6. Conclusion

Through research, we found that under the efforts of many scholars and game workers at home and abroad, a part of games about visually impaired people appeared in the market, but their main design is the physical abstraction of visually impaired people, focusing on the logical design of the game. The team found some unsatisfactory aspects of the use of the method, and summarized the shortcomings of most of the games currently on the market for the visually impaired:

- (i) Poor software operation experience: some related games have flashback phenomenon and low version. Frequent flashbacks can cause players to lose interest and also affect the emotional experience of the player, thus doing little to help special groups of people.
- (ii) Lack of educational significance of software: Most relevant games on the market lack of educational significance and correct guidance to help visually impaired people. Blindly focusing on the design of the logical structure of the game not only gives players a sympathetic experience of loss, but also makes it impossible for players to give correct help to the blind in real situations.
- (iii) The software is not interesting enough: some related games have boring plots and difficult operation. For example, a game produced by Tencent has some

defects such as too difficult operation and single game form, which causes some players to fail to fully experience the game, and thus fails to arouse players' sympathy and desire to help special groups.

The design of this project draws on the inexperience of existing related games in the market, and the improvement and innovation belongs to the characteristics and advantages of this project: Firstly, considering the game development cost, operation and maintenance, etc., the project development team chose the current mainstream mobile game development software Unity3D. Based on the professional engine and multiplatform of Unity3D, problems such as low version and game flashback were well solved, and the foundation was laid for future version update and platform release, etc. Second, in the game, the team through a lot of data access, field research methods such as a summary of visually impaired people inconvenience in daily life, the use of adaptive with the game, in the process of the game, the players in the control role to complete tasks at the same time, through the system prompt guidance, simulation of the visually impaired people under different difficulties with the help of the right way, Achieve the right help for visually impaired people in the face of similar difficulties. Finally, we put forward an innovative design method to integrate the reality. The team referred to many real environments and simulated the scenes in the life of the visually impaired people in the real society. Technically, since the whole process is made by static lighting, the final lighting effect is baked in Unity in advance. Secondly, based on the real situation of blind people, the game design is novel and the interface is simple and unique. It abandons the visibility of traditional games, and the player interface becomes dark after entering the game, which gives people a kind of depressed psychology. At the same time, the sense of real experience is more immersive. In reality, the visually impaired people cannot see the objects clearly, so the level of auditory sensitivity is set to encourage the players to give the players an immersive feeling in the sound.

Education based on Unity3D game "Inverse light" abandoned the traditional game visibility, abandoned the cookie-cutter story, the same game with the real innovation, not only can make the players to experience the game fun and significance of the game, but also strengthen the moral education of teenagers and care for the disabled, which has good social and practical significance.

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