Green City

Serious Game: Design of Garbage Sorting Game Applied to Chinese Preschool Children

Jingya Hong - S1943150
MSc in Design and Digital Media
Edinburgh College of Art
The University of Edinburgh
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Abstract

This is an initial exploration of serious games for preschool children. Finally, an educational 3D game for kindergarten environmental education was completed. It uses digital media in combination with classroom teaching to develop environmental awareness among Chinese preschool students aged 5-6. Although environmental awareness is a dynamic structure throughout life, it is important to lay the foundations of environmental awareness in childhood to demonstrate positive attitudes and behaviors towards the environment.
In China, such as Shanghai and Beijing, garbage classification has become a strict requirement, but it is difficult to implement because China started garbage classification late. This is why it is so important for children to develop a sense of waste separation at an early age.

In the exploration of this project, I studied the important role of serious games in preschool children, as well as the impact and advantages of digital education on children. Combined with the analysis of current Chinese garbage sorting related games, we have further explored and innovated a 3D garbage sorting game that is more suitable for Chinese preschool children aged 5-6, and made further exploration and innovation in design style, game operability, game mechanism.

CONTENTS

Chapter One: Serious Games and Education

1.1 Serious Games: Combining Digital Media Technology and Education

With the rapid development of digital media technology, digital media has been integrated with many aspects of our lives. For example, interactive electronic screens can be seen everywhere on roads and in shopping malls, with integrated and dynamic social and digital media platforms as well as virtual reality technology game experience pavilions in entertainment venues.

In the digital age, the media seem to be a powerful participant in social change, serving simultaneously as a tool, a means of communication, information, and knowledge. With the development of smart technology and the popularisation of social media, digital media has brought about profound changes in young people's media habits in terms of access to information, entertainment, and communication styles. The digital age means that the way we connect with the world would change significantly in a broader, more interactive and simultaneous way (Loicq, 2014). Sonia Livingstone is a professor of social psychology and former head of the Department of Media and Communication at the London School of Economics and Political Science. Most of her research is devoted to children, the media, and the Internet. She pointed out that the Internet combines the interactivity of digital media with new features such as the unlimited range of content and the global nature of dissemination (Livingstone, 2021).

Digital technology has become a direct participant in various processes through the production and distribution of its own user-generated content. This particularity of digital media has greatly affected and impacted school education methods, giving rise to a new education and learning environment. This provides new opportunities and challenges for the development of educational technology such as VR and AR technology, which can provide a realistic scene technology in teaching. In addition, Internet education, distance education, education-related applications, and serious games are also common. Amongst them, serious games have existed for some time as a way of providing knowledge. They have changed the way educators look at education to meet the needs of children. My final project is a practical project on serious games, and in the process of practice, I will explore how to better apply serious games to the classroom education of preschool children.

The term serious games began to spread in 2002 when the Serious Games Initiative was founded by the Woodrow Wilson International Center for Scholars in

Washington, DC. Generally, serious games are associated with games other than entertainment. The goals of serious play are the same as those of edutainment but go far beyond teaching facts and rote memorization to cover all aspects of teaching, training, and informing education for all ages (University of Skövde, Sweden, 2007). This description, while probably not a very in-depth definition, gives a general idea. This concept is the basis for understanding what a serious game is. The Serious Games Initiative homepage describes the Serious Games focus as using games to explore the management and leadership challenges facing the public sector. The aim is to help make somewhat productive connections between the video game industry and projects involving the use of games in education, training, health, and public policy. In other words, a serious game is a game that has a purpose other than to be applied for entertainment. The power of games is that they design experiences that allow players to participate in an ideal world designed to support certain types of emotions, and sometimes supporting ideas and identities that can be used for education and training. Serious games should also have this quality. Serious games are games, but with added educational content (Persson, 2014). Therefore, the possibility of using games in learning situations is immense, and it is crucial to explore the practice of serious games with educational significance.

1.2 The Advantages of Serious Games

According to a report from Future Lab, serious games are persuasive, constructive, suitable for the situation, and ideal for real skills practice as well as an entry point for media literacy. All aspects of these theories about gaming and learning are evident in the data (Williamson, 2009). This data in this report comes from a self-completion survey of more than 1,600 intern classroom teachers in public primary and secondary schools in the UK. The questions were designed by *Futurelab* and conducted by the National Education Research Foundation in a comprehensive survey of teachers in February 2009. Interviews were conducted with a teacher who participated in the use of school games, and 10 small groups of children who had experience in-game learning were interviewed. The findings of the report also indicated that most teachers believed that computer games contribute to the advancement of children's cognitive abilities and information technology abilities, as well as the development of higher-level thinking skills.

Existing literature has revealed that serious games have several advantages. Firstly, serious games increase participation and enthusiasm for learning, as they usually set up a fascinating environment or story-telling background. Due to the way games are designed, they use rewards, story progress, or other feedback systems to motivate players to keep going. Serious games and game-based learning are two effective ways to solve this problem. The interactivity of video games can

encourage players to put in the effort, and their narratives can also inspire students. As explained in the book 'The Gamification of Learning and Teaching', the more a learner interacts with other learners, content, and teachers, the more likely learning will happen (Christian and Bridgette, 2011). The authors argue that video games are often more effective in teaching and learning than detached, skill-based instruction. Students can use educational games to complete difficult tasks without feeling embarrassed when they fail, and teachers can use educational games to develop problem-solving skills and help students understand the meaning of lessons. Dr Sara de Freitas expressed that 'The advantage of serious game methods is that they can create game content specifically for learning purposes'. As learning tools, serious games can create specialised game content for learning purposes, support exploratory learning in formal and informal environments, and aid practitioners in attracting and motivating learners (de Freitas, 2006).

Secondly, game-based learning is different from face-to-face learning and training, as it is a form of practice-based learning. The game creates a safe, virtual environment where players can interact with other characters The simulated world in serious games should reproduce reality as faithfully as possible. On the other hand, it is an electronic game that allows users to practice under safe conditions without causing personal injury or other material damage. *'SG'* is a game with the main goal of learning, involving a personalised structure for individual users or groups. This game provide a learning environment of enjoyment, happiness, motivation, satisfaction, safety, critical, and creative learning, allowing users to explore skills, methods, and concepts (Protopsaltis et al., 2010).

Thirdly，unlike face-to-face courses (usually dozens of people in the classroom and a teacher), serious games provide instant and personalised feedback. Players directly interact with the game and immediately receive rewards or punishments. If used correctly, this feedback will be a powerful learning tool. A study of 300 fourth-grade children on the transfer of material in the curriculum showed that because games contained specific characters and interactive stories, they all shared certain basic elements. For example, the way tasks are presented and solved, receiving positive or negative feedback at the end of the task, interaction with competing characters, rewards, and score. The goal of this self-regulating system is to avoid depression and boredom (Gros, 2007).

1.3 The Use of Serious Games in Preschool Education

Recently, serious games have become increasingly popular not only as games but also as promising educational tools. The U.S. has been ahead of the curve in the research and application of serious games and has produced some cutting-edge

research in this area. In education, the most widely used online mathematics resource website www.m athleies.com of the American company 3pLerning, which is a game for students to support teachers' classroom teaching, has been used by more than 200 schools in more than 10 countries in Asia, North America, Europe and Australia (yuan, 2014).Especially in early education, teachers often use games to make lessons more interesting, more creative, and more attractive to children.(Kokkalia et al., 2021). In addition, some researchers consider serious games to be both fun and educational. With this in mind, a recent study presented the learning effect of the serious game Mijn naam is Haas on vocabulary growth in children (4-7 years old).The results show that this serious game has a significant increase in children's vocabulary(Schuurs, 2011).Therefore, it is very beneficial to apply serious games to early childhood education. Early childhood is usually defined as an age when learning is very important because it contributes to the development of children. Researchers believe that the purpose of preschool education is to allow children to acquire and develop knowledge and values, and learning is closely related to the development of the entire child (Hjalmarsson and Löfdahl, 2014).

Early childhood education includes many aspects, of which environmental education is also an important course of children's education. A research team conducted in the 2016-2017 school year used preschool education children's environmental awareness and attitude scale as a data collection tool for 138 children (69 experimental groups and 69 control groups) aged 60-72 months. The purpose is to compare the environmental awareness and attitudes of the children in the classes that implemented 'TEMA Kids' and those that did not implement 'TEMA Kids'. The research results show that the environmental awareness acquired during preschool education is effective for developing positive environmental attitudes (Öztürk Samur, 2018). Therefore, it makes sense to design a serious game about environmental protection for preschool children aged 5-6. On the one hand, developing children's environmental awareness is an important part of early education. As mentioned earlier, children aged 5-6 years old are the key stage in the formation of environmental awareness, and if children's environmental awareness can be strengthened with more effective and interesting means at this stage, it will improve the overall environmental awareness of society to a certain extent. On the other hand, serious games combine learning and playing and are an effective means of improving education and promoting learning in young children. Therefore, in the next section, I will analyze in detail the currently popular Chinese game of garbage sorting for young children about environmental protection.

Chapter Two: Case Studies – Serious Games Related to Environmental Education

Faced with the rapid growth of human resource consumption, China, as the world's resource-consuming country, is urgently seeking out an effective sustainable development path. The community is a certain geographical area based on the common living space, shared cultural concepts, and social bonds. Residents in urban communities are responsible for the classification of domestic waste regardless of the main body, and its garbage classification behaviour determines the success or failure of garbage management. Germany is one of the first countries in the world to carry out garbage sorting. In 1972, Germany promulgated the first garbage disposal regulations, and then further improved the detailed rules for garbage classification, formulating a number of regulations, and providing a complete legal guarantee for the advancement of garbage classification (Xiong, 2018). Japan is also one of the earliest countries in the world to carry out garbage classification. In the 1960s, Japan's rapid economic growth was accompanied by serious environmental pollution, and large-scale environmental pollution diseases such as pain and asthma began to surface (Lv and Du, 2016). To solve the problem of environmental pollution, Japan has begun to focus on environmental protection and carry out garbage sorting and treatment. In recent years that China has only begun to pay attention to and emphasise the work of garbage classification. There are still many issues with the regulations and the promotion of garbage classification, mainly due to insufficient public awareness(Li, 2021). When Shanghai's garbage classification regulations were promulgated, it caused extensive discussions on the Internet. Even if much attention is paid to all aspects of society, some will refuse to carry out garbage classification despite relatively strict garbage classification requirements. In addition, there are problems such as imperfect legal systems and insufficient industrialisation of garbage recycling. To solve the problem of awareness of garbage classification, it is necessary to start with education. According to the above conclusions, age 5 to 6 is a key stage for cultivating environmental awareness. For this reason, my goal is to design a serious game related to garbage sorting that is both aesthetic and educational for pre-schoolers aged 5 to 6. To better design this game, I researched several computer games suitable for children's garbage sorting. (See the following chapters)

2.1 Garbage Sorting Simulator

The game 'Garbage Sorting Simulator' is a Chinese garbage sorting game that uses real AR technology to restore the city screen. Upon clicking start, you will enter the trash can and see various types of trash on the ground. Players need to

find the appropriate classification and match the correct trash to the correct trash can to pass the game. This is meant for people of all ages. This game completely integrates practical common sense and games, so that more children can deepen the idea of caring for the environment and understand garbage sorting through playing games. Garbage Sorting Simulator has multiple levels, which increase as more garbage is sorted. However, when the player enters, they face a lot of garbage and directly classifies it. It is not possible to experience the fun of augmented reality in-depth. I think the player must interact with the scene to better increase the player's interest in exploration.

Figure 1: Screengrabs from 'Garbage Sorting Stimulator'http://www.paopaoche.net/android/485900.html

2.2 Baby Learns Garbage Sorting

The game 'Baby learns garbage sorting' is divided into two parts: garbage disposal and garbage sorting, allowing children to master environmental protection knowledge through interaction and games. For garbage classification, the army of garbage will pollute the fields and rivers and causes the flowers to wither. Players can choose eight different characters as their avatar, each of whom has unique abilities. Players must put the garbage in the corresponding trash can to save the flowers and protect the environment. For the garbage treatment part, players will need to place recyclable garbage and dangerous items in the right place to win the medal.

The protagonist of the game is a panda, with an overall cartoon style. Setting up two modes allows players to understand the knowledge of garbage classification, and instils a deep memory of the knowledge of garbage disposal. Although the game is full of childlike and educational significance, the sense of immersion is not very strong for children as the game is a flat game mainly controlled by mouse clicks. It is only suitable for after-school entertainment and cannot be combined with classroom teaching.

Figure 2:Screengrabs from 'Baby Learns Garbage Sorting'http://www.paopaoche.net/android/485075.html

2.3 Garbage Sorting Machine

This is a smartphone game with the theme of garbage sorting. In the game, players need to divide all kinds of garbage on the earth into three types. If a mistake is made, there will be hints. The gameplay is simple and fun, and test the players' perception of garbage. Players only need to drag and drop with their fingers, suitable for players of all ages.

This game uses 3D graphics design and a variety of garbage that players need to carefully distinguish and sort into the correct trash can. However, the type and number of trash cans in this game when sorting trash does not match those in real life, which can easily mislead children. In addition, the interactive experience of the game is not good, there is neither level setting nor score tips in the game, which

leads to the user's experience of the game is not strong.

Figure 3:Screengrabs from 'Baby Learns Garbage Sorting'http://www.paopaoche.net/android/553278.html

2.4 Comparison and Inspiration

The combination of the above-mentioned case studies and the characteristics of serious games inspired me to design a 3D interactive serious game. First, it must be close to reality. The design must not only simulate real-life scenes but also be full of child-like elements to stimulate children's interest in exploring the game. Secondly, the game mechanism settings must be simple and easy to understand, so that they can be easily operated by children. Finally, the interactive settings of the game need to allow the player to be immersed, increasing the enthusiasm of the players through competition or scoring to maintain the stickiness of the player and the game.

Chapter Three: Project Design Process

3.1 Overview-Game Introduction of the Final Project

This will be an educational 3D game called Green City for environmental education in preschools. It uses digital media in conjunction with classroom teaching to develop environmental awareness amongst Chinese preschool students aged 5-6. This is a multiplayer online game. Teachers can apply it to pre-school classrooms, combine teaching and games, and mobilise students to participate together.

China is now gradually advancing the garbage classification policy. The cultivation of environmental awareness is best at the age of 5-6, and serious games can bring better educational significance. This game is set in a city. After the player selects the character, they can pick up garbage on the roads of the 3D city from a third perspective and place the garbage into the correct trash can to earn points. This game can be combined with classroom teaching. Teachers can guide students to participate in this game to consolidate the knowledge of garbage classification after explaining the knowledge of garbage classification. This will allow children better understand how to sort garbage.

The main gameplay is that multiple players enter the scene together and pick up garbage in the game, and then quickly run to the 'garbage station' in the centre of the city. Players classify and put the garbage they see according to the different materials of the garbage and receive one point for the correct classification, and no points for errors. The first player to score 10 points wins, the game mechanism is simple and easy to operate.

3.2 Model Design

3.2.1 Low Poly Modelling Scene Design

I chose a low poly design style for this final project. My inspiration comes from a lowpoly 3D video and a game – *Polyville Canyon and Minecraft*. Low poly is my favourite modelling style, as it is more cartoonish compared to high-simulation 3D models, which is more suited to the target demographic here. Low polygons are a more mature style in video games, as they serve the dual purpose of shortening development time and giving games a unique aesthetic style.

Figure 4：A screenshot of a 3d video from a city called City

Figure 5：Screenshot from a game named Boll Polyville Canyon and Minecraft.

My initial inspiration came from Japanese anime scenes, and Japanese animation is very popular in China. This style design focuses on character characteristics and images and does not emphasise realism. It usually uses three-dimensional characteristics and novel design expression techniques to complete the character shaping. I thus researched some scene buildings in Japanese anime.

Figure 6:The house of the classic Japanese anime "Crayon Shin-chan".

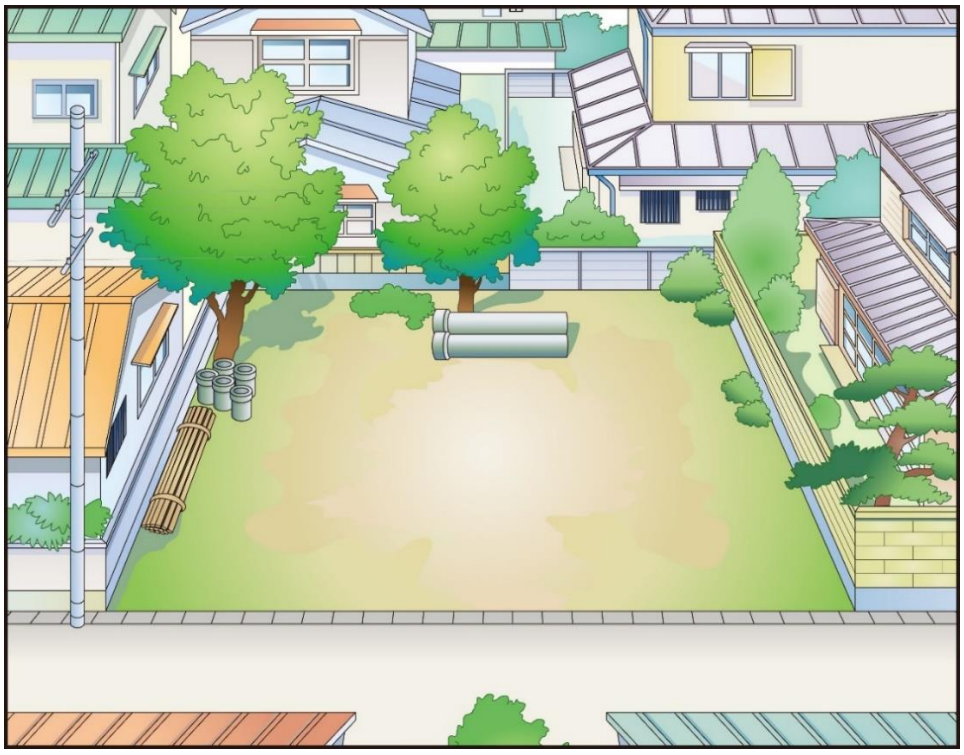

Figure 7:Japanese anime Doraemon scene

First of all, I established a networked urban terrain in Blender, as the complex terrain for preschool children will cause more interference. The networked terrain is clear and simple, which shows the city more intuitively.

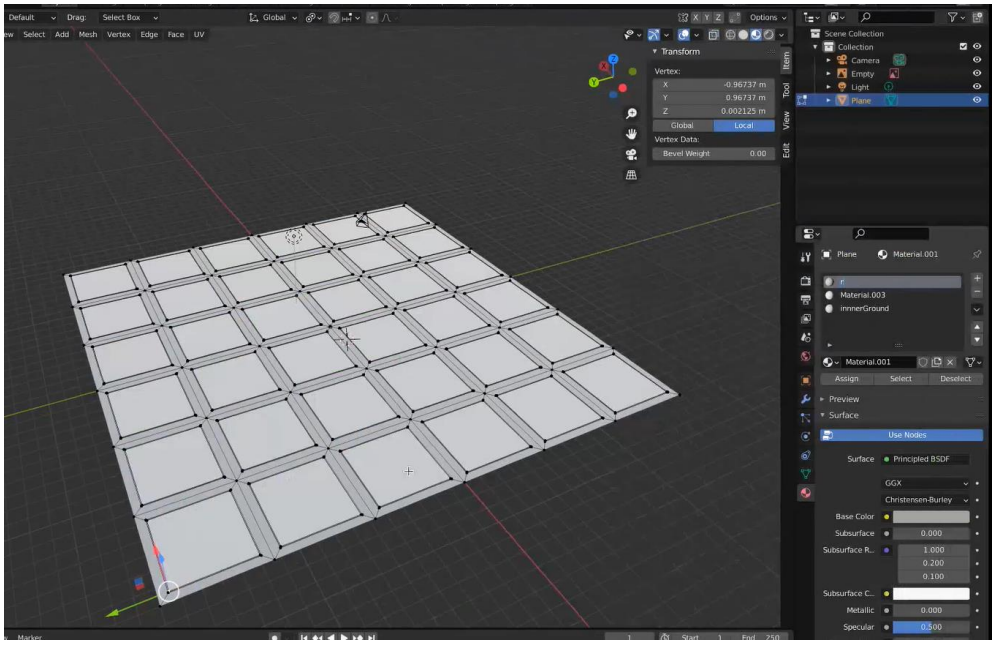

Figure 8：Screenshot of the modeling process

Combining the above sources of inspiration, I designed some architectural shapes. In addition, based on the previous research, low-polygon style game scenes do not pursue the 'realism' of the real world. Therefore, unlike the production of general three-dimensional game scenes, there is no need to specify different materials for different objects. It would be sufficient to use colour to express scene elements.

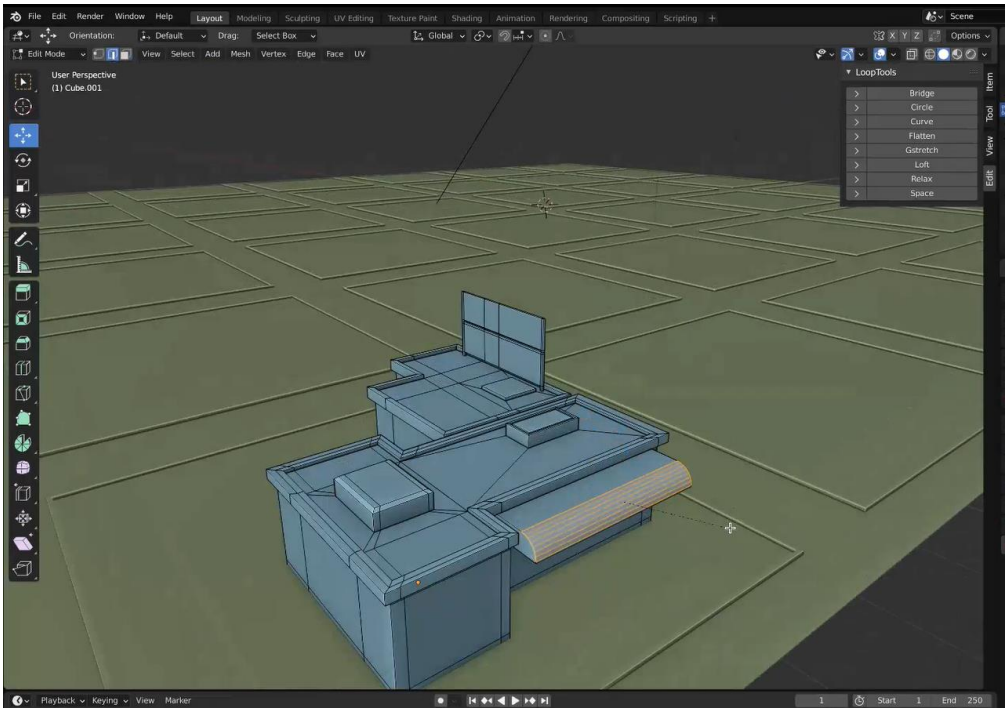

Figure 9：Screenshot of the modeling process

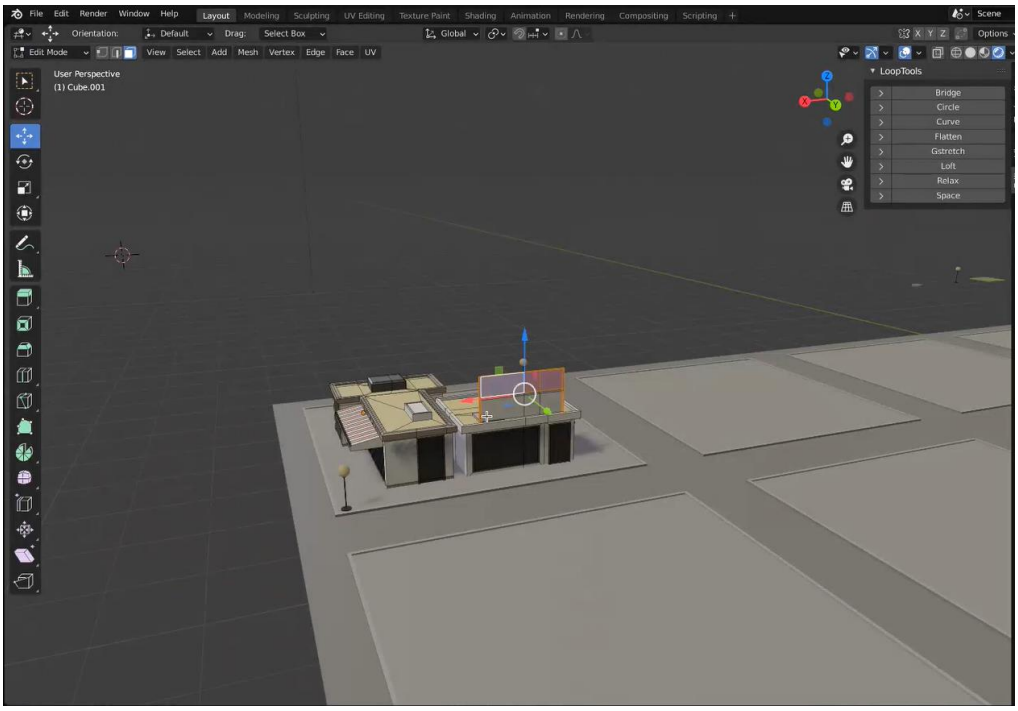

Figure 10：**Screenshot of the modeling process**

To increase the highlights of the city, I designed some buildings with unique signs, such as doughnut shops, pizzerias, and hot dog shops as shown in Figure 5 (below). These buildings have iconic models on top of the basic model of the original house, such as the doughnut model and the hot dog model, which allows players to experience the richness of the scene more intuitively.

Figure 11：Screen shot of model rendering

Figure 12：Screen shot of model rendering

Figure 13：Screen shot of model rendering

In addition, to be closer to real-life and increase the immersion of the game, I designed some models with brand logos, imitating some brand shops that children in urban communities in China would generally frequent, as shown in the following figure:

Figure 14：Screen shot of model rendering

3.2.2 Core Scene Design

This game is mainly to promote the mastery of garbage classification and better cultivate environmental awareness for preschool children. Therefore, the design of the 'garbage sorting station' in the game scene is particularly important. First, according to the current status of Chinese garbage classification, Chinese garbage classification is mainly divided into four categories: recyclable garbage, other garbage, kitchen waste, and hazardous garbage. Recycled materials mainly include waste paper, plastics, glass, metals, and fabrics. Other garbage (referred to as 'dry garbage' in Shanghai) includes bricks, ceramics, muck, toilet waste paper, paper towels, and other items that are difficult to recycle except for the above-mentioned types of garbage, such as dust and food takeaway bags or boxes. Adopting a sanitary landfill can effectively reduce the pollution of groundwater, surface water, soil, and air. Kitchen waste (called 'wet waste' in Shanghai) includes leftovers, bones, vegetable trimmings, food waste, and leaves. Hazardous waste contains heavy metals that are harmful to human health, toxic substances, or wastes that cause actual or potential harm to the environment. Then I investigated the colours and shapes of the current garbage sorting stations and garbage bins in China.

Figure 15：Photographed by mobile phone in the community garbage classification bulletin board in Beijing

Figure 16：China garbage classification standard trash can

Based on the above research, the shape and colour of the trash can I designed are nearly the same as in real life. Since this is a game mainly used for garbage classification teaching, four trash cans with obvious signs are built in the middle of the scene. To better attract the attention of players and improve the recognition

of scene, the four trash cans are connected to form a castle shape as shown below:

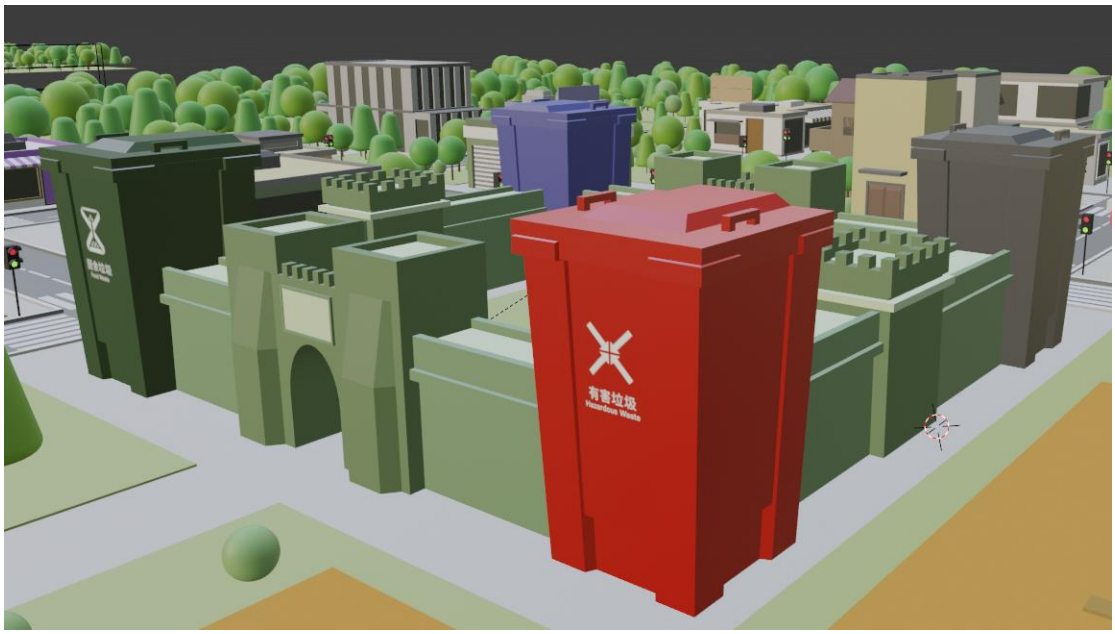

Figure 17：Screenshot of the modeling process

In addition, since the target users are preschool children aged 5-6, it is also necessary to design a small trash can that is more suitable for the child's height and field of vision for the garbage disposal. In the middle of the castle with four large garbage cans set up a grass and garbage cans for players to put garbage.

Figure 18：Screenshot of the modeling process

3.2.3 Game Facilities Design

The name of this game is Green City. The main purpose of this project is to enable children aged 5-6 to grasp the knowledge of garbage classification and gain further environmental awareness. Therefore, in addition to the city's theme building modelling, greening and some supporting facilities are needed in the game scene. Greening reflects the environmental protection of the city to a certain extent and can be used as a decoration for the overall game scene. The model of the tree mainly refers to the shape of the tree in a 3D video named City.

Figure 19：A screenshot of a 3d video from a city called City

Figure 20：Low polygon trees

Although the overall game style is lowpoly, the buildings and terrain are relatively regular objects and structures with obvious edges. I thus chose a design with a smoother surface and a stronger sense of arc in the green design.

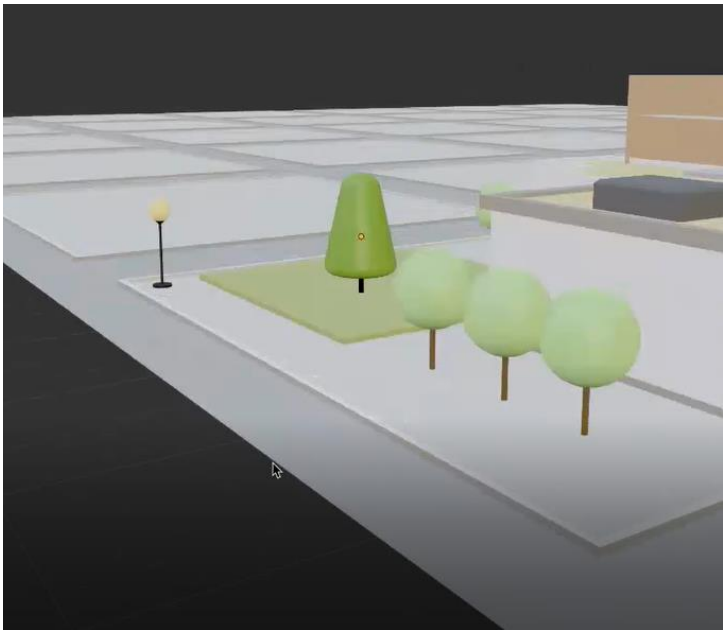

Figure 21:Screenshot of the modeling process

3.2.4 Other Models

The design of traffic lights and sidewalks is for future development. In the future, this project can be used not only for educational games for garbage sorting but also to increase the function of traffic knowledge through the traffic lights. Players can follow the traffic rules while searching for garbage in the city. For details, see Chapter 4 Feedback and Future supplement.

Figure 22： Screenshot of the modeling process

In addition, according to the different categories of garbage classification, as well as the more common garbage in daily life. I designed 18 different garbage models, such as cans, glass bottles, and plastic bottles.

Figure 23：Screenshot from the model rendering

3.3 Character Design and Character Animation

The role of the game is the carrier of interaction between the game and the player. The aesthetics of the role directly affects the player's experience of the game and is also the player's first impression of the game. According to different game expression effects, cartoon-style expression techniques can be divided into Q version and semi-realistic. In games with a relaxed and pleasant atmosphere, there are often cute, lovely, and clever Q version animated characters and the colour design of the characters tends to be bright and vibrant. Such characters and works are relatively more popular with children (Wang, 2017). Therefore, to attract players and introduce diversity, I began to pay attention to the details of the character during the design process. The shape of the character is more in line with the positioning of the game, and the character setting animation also pays more attention to hair colour and skin tone. In addition, I referenced some of the character designs in 'My Life' as follows:

Figure 24：From ‘My Life’ Game Interface

To make the characters and the scene more unified, I also chose a low-poly character design. Moreover, to increase the interest of the target users, I designed two cartoon images closer to children aged 5-6. A character image of a boy and a character image of a girl.

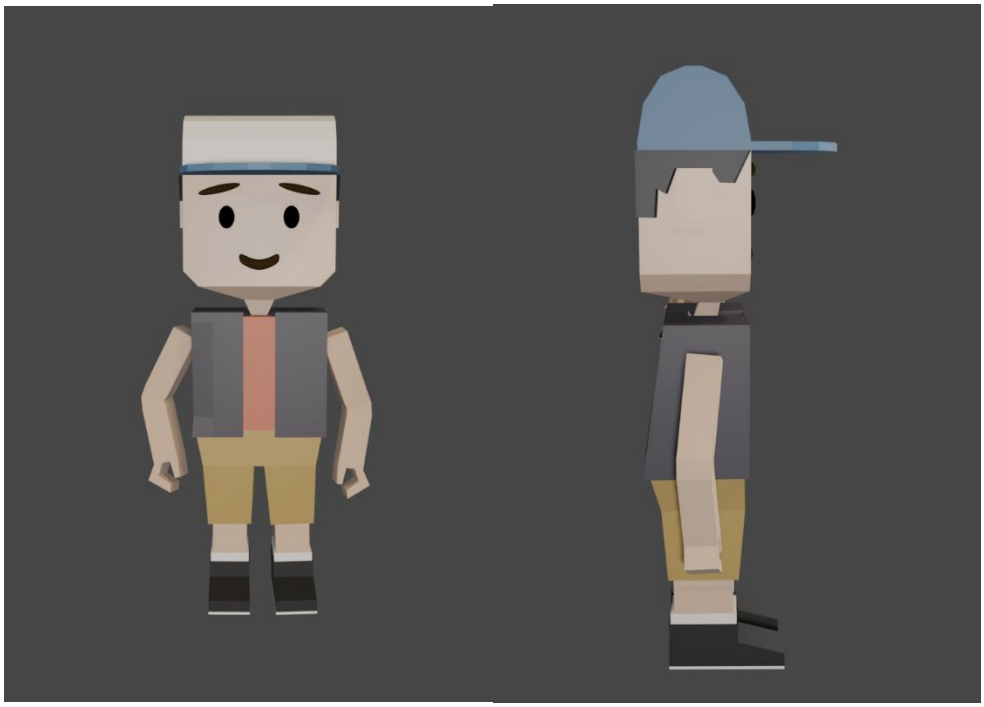

Figure 25: Screenshot from the model rendering

Figure 26: Screenshot from the model rendering

To facilitate the movement, picking and jumping of characters in Unity, I need to make character animation effects in Blender. After the character model is established, the bones need to be bound, and the state of bone binding is adjusted according to the relationship between the model and the bones. Next, 'Add IK' creates a linkage mode between bones. Then, the character's bone state need to be adjusted according to the person's walking state, and keyframes are set to make animation. Following the above method, I created animations of characters walking, picking up trash and jumping.

Figure 27: From the screenshot of the model animation setting

3.4 Gameplay

Game mechanics are the core rules of the game that define the game, the process of game development and the data. They define how the game progresses, what happens when, and what conditions determine victory or defeat(Adams and Dormans, 2012). In my game settings, players play the game from a third-person perspective. First of all, the biggest feature of the game mechanism of this game is that it can be accessed by multiple people and controlled online under the LAN. Each player can choose the character image of the system and enter a nickname. Currently, there are images of a girl and a boy. After players enter the game, they start picking up rubbish from the street and the ground around the store. For example, beverage bottles on the ground in cities, paper airplanes, broken game consoles, batteries, and daily kitchen garbage. The garbage capacity that each player can pick up is 8 items. When the garbage is full of 8, the player needs to go to the garbage disposal station in the city center to sort the garbage into the corresponding garbage bins. Players will get one score if they put trash into the correct trash can according to the nature of trash and will not score if they make a mistake. Whoever scores 10 points first will win the game.

3.5 Game production

In addition to importing model scenes, importing character animations, making scene collisions and basic operations of the environment, I also use the mirror plug-in.

Mirror is Unity's high-level network API, which supports different low-level transmissions. The client and server are in the same project, which is why it is called Mirror. In other words, it does not have an independent server, but a client as the Host. It is both a client and a server, and other clients connect to this Host client. But at present, I can only realize that multiple clients can enter the game together on one computer. Due to the limited time and ability, it is impossible to realize that multiple devices under the local area network can enter the game as the client at the same time.

Figure 28: Screenshot of the game interface

In addition, since the target users are pre-schoolers aged 5-6, although the terrain of the game scene is regular, pre-schoolers may lose their way in the game when using it. Therefore, the design of the game is from the user's point of view. I set a small map in the upper right corner of the game interface. It is convenient for players to check their position in real time during the game, and accurately find the location of the trash according to the map.

3.6 Control and UI

The control of the game is kept simple and straightforward. Players use the w key to move forward, the s key to go back, the A key to go left, and the D key to go right. In addition, to increase the fun of the game, they can jump by pressing the SPACE key. The mouse controls the player's field of vision up, down, left, and right.

Since the target users are pre-school children aged 5-6, the UI design style is also close to the overall theme and style of the game. The interface is simple and clear, allowing players to quickly master the game mechanics and game rules. The overall design of the UI selects iconic models and patterns in the model scene to deepen the target users' impression of the game theme and overall style.

Figure 29: Game User Interface screenshot

Figure 30: Game User Interface screenshot

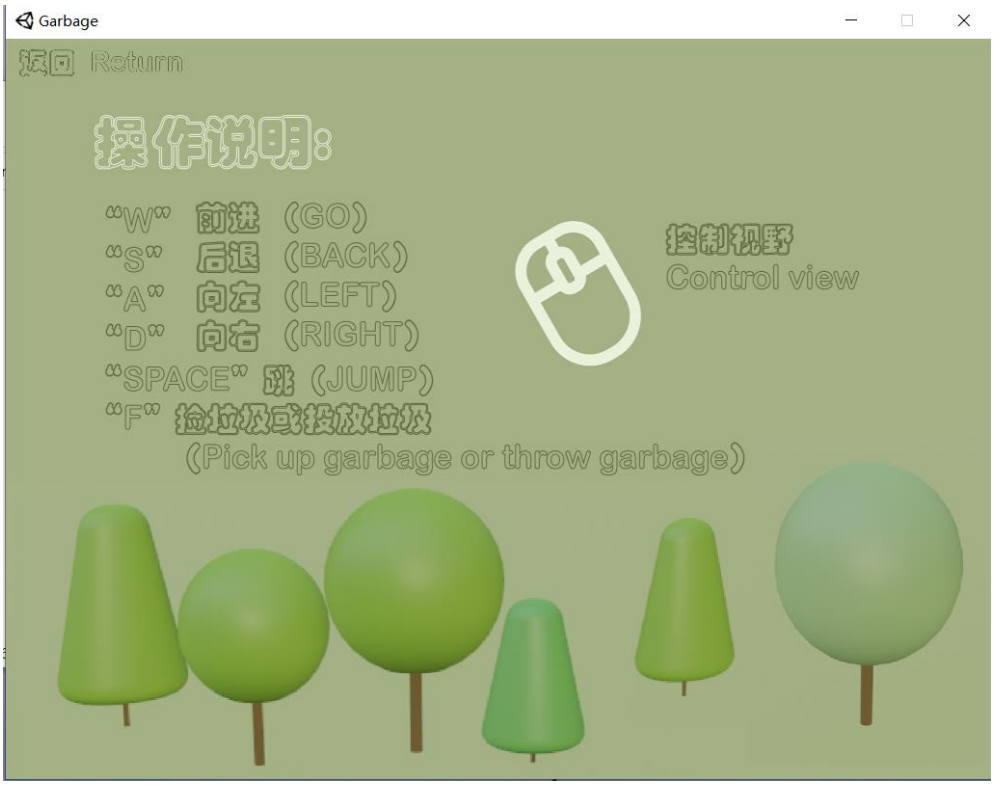

Figure 31：Game User Interface screenshot

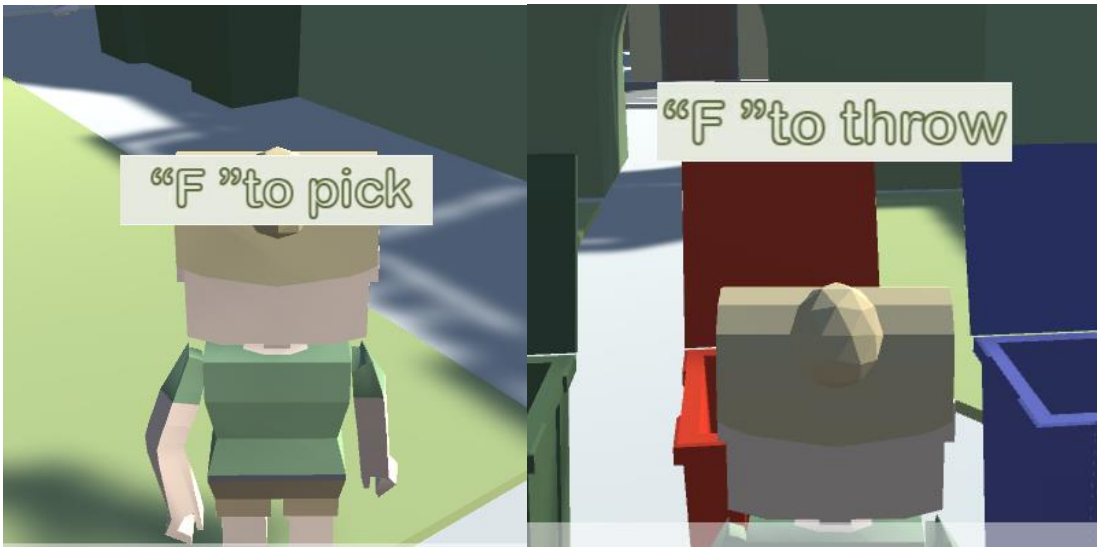

Figure 32：Game User Interface screenshot

3.7 Conclusion

In this section, I introduce my design process from the aspects of scene modelling, scene elements, character modelling, character animation, and game mechanics. In each section, I explained my design inspiration and methodology to better understand my creative process as a game designer. The innovation of this game is that it is simple and convenient to operate, and the game interface and visual style are attractive. The important thing is that it can be operated online. In the local area network, multiple people can simultaneously enter the game. The purpose of using games in education is to help students remember what they have learned and to encourage active participation. Learning shouldn't mean rote memorization, but students can use games to remember points that they can apply on exams and in real life(Samuel Zirawaga, 2017). Therefore, using this game in the classroom of preschool children, combined with the knowledge of garbage sorting, can strengthen the memory of garbage sorting knowledge to a certain extent and can also improve the awareness of garbage sorting. More design process can check my blog：http://s1943150.edinburgh.domains/
Green City game display and operation links：
https://media.ed.ac.uk/media/t/1_gov5nqv8

Chapter 4: User Feedback and Further Development

4.1 User Testing and Feedback

Five kindergarten teachers, as well as four digital media related students and a friend who works in software testing, were invited to conduct my user testing. The program files were sent to them, and they responded with their feedback via email or WeChat. Based on their feedback, I will summarize the feedback in terms of operability, playability, style, UI, and practical application.

In terms of the game's operability, the game's control key settings follow the settings of most games, w, a, s, d keys used to operate the direction, and according to the test feedback from kindergarten teachers, the game is still relatively easy to operate for children aged 5-6. However, it was also suggested that since only the PC version has been developed, if serious games are invoked in the actual teaching classroom, it is more likely to use iPad, because ordinary classrooms are generally not set up computer will generally use iPad, the school generally set up a special computer classroom for students to use the computer, so the computer side of the operation will be limited by the space.

Secondly, in terms of the playability of the game, the game is more suitable for preschool children aged 5-6 because of the simple rules and game mechanism. However, according to the feedback, users hoped to include settings for passing or unlocking new maps. This will differentiate the difficulty level of the game and increase he psychological challenge for the players. In addition, since this is an online game, multiple players can simultaneously operate in the same scene, thus it is to a certain extent conducive to competition and the cultivation of collective consciousness. Thirdly, in terms of the game style, early childhood educators have expressed that the overall picture style is more suitable for children aged 5-6 years old, and some cartoon-shaped buildings did stimulate children's interest. A number of digital media-related students felt that the overall game painting style was soft enough for different genders and ages, while the overall coordination style is more unified with a clear picture.

Additionally, the overall layout of the overall UI was thought to be relatively reasonable and the interface relatively clear. However, according to the feedback users may want to provide more option s for the game character image at the beginning. Fifth, in terms of the feasibility of the practical application of this game, kindergarten teachers think that this game may be able to improve young children's awareness of waste separation, but more in-depth research and experiments are needed. If this game can be further developed to create more application scenarios, it will improve the practical feasibility of this game.

4.2 Further Development

At present, 'Green City' game still has many shortcomings, and in the future, I want to improve this project even more. I will first need to further expand the knowledge capacity of this game and increase its feasibility. As aforementioned, I also set up some traffic lights and crosswalks in the modelling design process. This project can determine the route of players picking up garbage by including traffic rules and street signs. For example, when encountering traffic lights, players will need to stop and walk accordingly, which can also combine common sense traffic rules with the classroom environment to make this project more feasible.

The project's gameplay and entertainment will be further expanded. In the future, I want to include different levels and maps in the game to apply them in more practical scenarios. Since I have only developed a LAN online interaction so far, I plan to develop online games that are not limited by LAN in the future, add the friend function, and invite peers to collaborate online to complete a certain task. Through these opportunities, the entertainment value and gameplay of the game may be enhanced.

More versions need to be developed for it to apply to a wider range of realistic situations. According to user feedback, it is not just preschool children who need to develop this awareness of waste separation, but people of all ages. Since the waste separation program has just begun in China, many still have a vague understanding of the nature of waste and its classification. During the testing process, I found that some adults could not accurately identify the types of waste. Therefore, I want to develop more versions of the game catered to different age groups, so that more people can gain awareness of garbage sorting and environmental protection. In addition, according to the feedback, the application of the PC game in the classroom is limited by the space it requires, as some classrooms do not have computers. It is thus necessary to develop a tablet version to make it more suited to the classroom.

Finally, the game's periphery needs to be created and the potential resources around it could be explored. This can be accomplished mainly by introducing medals or trophies with local environmental organizations or school departments to reward students who have achieved a good ranking in the game. This reward mechanism will further promote the game and generate interest and increase student participation of students.

Chapter 5: Conclusion

The research on serious games in this paper is still in the exploration stage, and the ultimate purpose of the project is to better integrate serious games with preschool children's classroom teaching through digital means. It also takes an important practical step to explore how to design serious game designs that are more suited to preschool classroom teaching. During this practice of exploration, I thus studied the entire process of the project more deeply and accumulated experience and thoughts.

Creating an environmental education game for preschool children was a new challenge for me. However, compared to the garbage sorting games currently available in the Chinese market, the innovation of my project is that it is a LAN online game, allowing up to 10 players to simultaneously play the game. Therefore, when targeting classroom application scenarios, this game would be beneficial for teachers to encourage participation in the classroom. In addition, as mentioned in Chapter 2, many garbage sorting games designed for children in China are in 2D or flat style. My innovation is to create interesting 3D scenes with more prominent visual effects, which also increases the game experience.

The process of creating a game and exploring how to maximize its effect also brought me a lot of thoughts. I continuously modified and considered how to allow the design elements to be more harmonious and unified, and how to attract the target demographic with an elevated style of graphics in the design process. I started from the characteristics of target users, divergent my own thinking that was not limited to a certain type of visual style, but more thinking about the project application scenario. For example, the design modelling incorporates a lot of child-like elements, brands that would be familiar to them. In addition, although my project is currently aimed at children aged 5-6 years old, the user testing for design style and graphics received unanimous praise, indicating that it conforms to the visual aesthetics of adults, providing more room for further development of the project. However, due to limited time and ability, I only realized the ability to create multiple clients on the one device in the local area network to log in to the game at the same time, but did not realize the function of simultaneously logging in to the game on different devices in the local area network. If I could develop this project in the future, I will improve this function.

Finally, the feedback from the game demonstrated its potential to raise awareness of waste sorting. The scoring and feedback mechanism of the game allowed for clearer identification of the types of waste, and improved users' awareness of garbage sorting, highlighting the practical effect of this project.

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Game plugin：https://mirror-networking.com/

Game environment sound:

https://www.aigei.com/s?q=%E8%84%9A%E6%AD%A5%E5%A3%B0&type=sound

https://www.aigei.com/s?q=%E5%8F%AF%E7%88%B1%E5%92%BB-%E8%BD%AC%E5%9C%BA%E7%9F%AD%E9%9F%B3%E6%95%88-%E6%83%8A%E5%96%9C&type=sound&detailTab=file

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Appendix

User research interview questions:

1. What is the overall feeling of the game

2. Do you think this game could be used in preschool classrooms?

3. Can this game improve children's environmental awareness ?

4. Will teachers in kindergartens now use serious games in the classroom?

5. Do you think this game can be promoted?

6. What do you think the game needs to improve?

THE UNIVERSITY of EDINBURGH
Edinburgh College of Art

SCHOOL OF ARCHITECTURE & LANDSCAPE ARCHITECTURE

Interview Consent

Name of Teacher: Dr Agnese Sile

Contact Details: Agnese.sile@ed.ac.uk

Name, ID and email of the student conducting the interview:

Jingya hong s1943150

s1943150@ed.ac.uk

Thank you for agreeing to this interview. You will be asked questions about some aspect of your involvement with digital media. The conduct of the interview will comply with the health and safety rules that apply at the time and place of the interview.

- This project is conducted by a student in the courseDesign and Digital Media: Final Project and will form part of an assessed submission.
- Your interview will be recorded on video and with sound and may be edited (amend as necessary).
- The material will be viewed by lecturing staff and may be used for instructional purposes in this or future years.
- The material will only be available as course content restricted for use by students in this course and will not be made public without your permission.
- Note that you can withdraw from the interview and terminate the process at any time before, during or immediately after the interview.

Please sign this form if you are 18 years of age or over and consent to be recorded as outlined above.

Name of person being interviewed:

Signature: Zhang Mengdan

Contact email:

THE UNIVERSITY of EDINBURGH
Edinburgh College of Art

SCHOOL OF ARCHITECTURE & LANDSCAPE ARCHITECTURE

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Name of person being interviewed:

Signature: Jingya Qi Xiaolei

Contact email: s1985638 @ ed. ac. uk

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Signature: 许科毅 Lu keyin

Contact email: w0563156 6@qq.com

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Name of person being interviewed:

Signature: 王婧 Wang Jingya

Contact email: 1017532516@qq.com

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Name of person being interviewed:

Signature: 陈璟婧 Chen Jinghong

Contact email: 1453190338@qq.com

Interview Consent

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Signature: Qing Wen

Contact email: --

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Signature: Luoying Bao

Contact email: rowlingbaby@outlook.com

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Name of person being interviewed:

Signature: Louis Liu

Contact email: 958149423@qq.com

Interview Consent

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Contact Details: Agnese.sile@ed.ac.uk

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s1943150@ed.ac.uk

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