# DESIGN AND DEVELOPMENT OF MORAL EDUCATIONAL GAMES BASED ON MOBILE TERMINAL

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With the development of information technology, educational games have become an instructional tool to make students learn and can run on a variety of mobile terminal which can provide a more user-friendly environment for mobile learning. In this study, the authors search a lot of literature to understand educational games. Secondly, the authors put suggestions on game design and development for moral education according to the theory of Education Design Research (EDR). The design consists of three parts, which are instructional design, scene design and script design. The development includes environment and structure development, user interface development, game scene development, script system and algorithms of artificial intelligence. The main purpose of this paper is to develop a moral educational game based on mobile terminal for primary schools and present a framework of the moral educational game research. It also provides some experience about design and development of moral educational games.

*Keywords*: Moral educational game; design and development; mobile terminal.

## 1.  Introduction

Educational games are meaningful activities that contain some of the following elements: rules, goals, challenges, enjoyment, mystery, curiosity, competition, and skills (Garris, Ahlers, & Driskell, 2002; Randel, Morris, Wetzel, & Whitehill, 1992) that are used to serve the emotional and educational cognitive goals. There are many kinds of educational games: some are simulation-based games (Polycarpou, Krausea, Rader, Kembel, Poupore, & Chiu, 2010), some are web-based learning through educational games (Kristian, 2005), and some are digital educational games (DEGs) (Law & Sun, 2012).

However, we found that the educational games have been applied in different subjects, such as mathematics, physics, English, biology, history and so forth. But there are not many successful cases of educational games for moral education. There are many theories adopted in educational games, but they have not formed a theoretical framework for educational games. In this study, we will apply a new theory "EDR" to develop an educational game for moral education which runs on mobile terminal for primary schools. We will introduce the "EDR" theory and the reasons why we adopted it. Then we will show the design and development of the moral educational game.

## 2.  Literature Review

Analysis of a large number of articles about moral games includes four parts: the theory of educational games design, the design and development of educational games, the application of educational games in teaching, and the importance of moral education. In the first part, we mentioned many theories adopted in educational games design by other researchers that are the flow theory, the activity theory, the constructivist learning theory and the collaborative learning. But the purpose of this part is to introduce the "EDR" theory which we have applied in our educational game research. In the second part, we will illustrate the design and development of several educational games, and introduce our process of moral educational game. In the third part, several educational games are applied in teaching to indicate the effect whether the games have improved the academic achievement or not. In the last part, we will show why we want to design an educational game on moral education. In other words, we have found the moral education is important to students in primary schools. But there are not many methods of information

technology being applied in moral education, and we try to design a moral educational game based on mobile terminal.

### 2.1. *The theory of educational games design*

A lot of researches report the theories of educational games and game-based learning. They want to form theoretical frameworks of educational games design. Csikszentmihalyi (1975) described the flow state of people who involved in activities. The purpose of using the Flow Theory in educational games is to create an optimized learning environment. Learners lost themselves in the environment and achieve the best efficiency (Tao & Wang, 2009). Another theory applied widely in educational games is Activity Theory (AT). It is rooted in the work of Vygotsky (1978) and his student Leontiev (1978) (Law & Sun, 2012). The AT is also a theoretical framework which explains the continuous interaction that constitutes games and the wide contexts that situate the gaming activity. Some other researches discovered that the constructivist learning theory and the collaborative learning are also applied in designing educational games. Maja et al. (2003) observed that constructivist means an exploratory approach for learning. Learners will become active when they interact with others. Collaborative learning makes the knowledge meaningful, organized, and permanent.

However, this educational game is based on the EDR (Education Design Research). It is also called Design-Based Research. But it has not been called uniformly so far. The EDR is a new research paradigm. It is come up in the early 1990s because of the growth of the Learning Science (Wang, 2009). Some researches reported the theory of EDR. For instance, Shavelson, Phillips, Towne, and Feuer (2003) found the characteristics of EDR are iterative, collaborative, interventionist, process focused, multileveled, utility oriented, and theory driven. Brenda (2003) observed that stages of designing in researches, informed, exploration, enactment, evaluation: local impact, and evaluation: broader impact. Some researches discussed the cases based on the EDR. For instance, the program "Literacy Access Online" (LOA) (Brenda, 2003) promoted the learners' abilities of reading and writing.

This educational game is based on the EDR, because it combines the theory with the real surroundings. In this research paradigm, we have also applied other research methods, such as questionnaire survey, experimental methodology, and content analysis. EDR asks the researchers and participants to work together in order to attain the results. Moreover, the EDR is iterative so that we can adjust the results constantly.

### 2.2. *Design and development of educational games*

Educational games designers focus on the creativity and instruction of a game. Norizan, Khaliq, and Marina (2010) designed a kind of educational game named "MathRush", which runs on mobile device for mathematics education in primary schools. They tried to describe the components that are required for the development of a mobile game. The prototype development process combines the instructional systems design and the game development approach. The Korean game "Sangokushi" is a kind of RPG (role playing

game). In the game, players can play the role of historical figures. As a historical figure, players will learn history with the game storyline. The MIT (Massachusetts Institute of Technology) and Microsoft within the Games-to-Teach project developed several educational games such as the Environmental Detectives (2002). It is designed to be used in any environmental education context. Students can learn basic investigative skills that are a part of any environmental education curriculums.

This moral educational game is developed to run on the mobile terminal. We designed it through three sections: instructional design, game scene design and script design. And we developed this moral educational game by development of the user interface, development of the game scene, and script system. We will present the detail of each part so that you can understand it clearly. In the process of design and development, we try to modify the moral game many times according to the users' feedback.

### 2.3. *The application of educational games in teaching*

Today educational games become more popular and successful teaching methods, and are almost used to teach in all courses, especially in science teaching. The lesson will become more enjoyable and interesting through games, and students are more motivated (Ün Açıkgöz, 2006). Students gain experience, develop tactics, find solutions, and make many decisions while playing (Naim, 2012). Şaşmaz and Erduran (2004) found that teaching through games is more effective in improving academic achievement in science teaching when compared to traditional teaching (Naim, 2012). Polycarpou et al. (2010) designed the game called "Math-City" for improving K-12 students' achievement in mathematics. The feedback observed that the teachers would like to use the game as a supplement to their teaching material.

However, the games for moral education are rare, and there are not many successful cases. Meanwhile, the achievement of moral educational games is not satisfied. For instance, the "Adventures in Odyssey and the Sword of the Spirit" is a kind of moral educational game. But the game did not achieve its goal. The idea of it was not perfect, and it was not suitable for players. It also lacked the theoretical supporting.

### 2.4. *The importance of moral education*

As is known to all, moral education is very important for a country and society. Students are the future and the hope of a country and society, so to enhance their moral education has become especially significant (Wang, 2011). The teachers also play important roles in students' moral education. For instance, Temli, Sen, and Akar (2011) made a study on primary teachers' perceptions of moral education. They found the reasons why they thought moral education was important: the role of school, family and social milieu issues, teacher effectiveness and quality of education and so forth. And they found the teachers put more endeavors to train students to become academically successful people than to train them to become moral people and although they were both crucial, a difference was set between instruction and education. There are some teaching methods are applied in moral education. For example, Abed, Hassan and Cobra (2011) also

studied the effectiveness degree of active teaching methods on moral education of the fifth grade students in primary school from teachers' point of view. They observed that application of active teaching methodologies could be one of the most effective factors in moral education of students in elementary schools. The active teaching methodologies have an impact on cognitive, affective and behavioral aspects of moral education. The moral education is not only taught in the moral education curriculum, but also in other curriculums. For example, Wai-Chung Ho (2010) discussed the moral education through Chinese music education, because the music education has been influenced by recent social changes and modernization. In China, some school music curriculums present new moral educational principles, for example, school music can be seen as a model for lifelong practice, and an awareness of rich cultural dialog and social harmony.

In summary, the moral education plays an important role in school education, and we should apply many methods for teaching moral education. Moreover, the teachers must pay more attention to moral education. However, we found the methods of moral education are ancient, and we should adopt new media or new technology. So we adopt the games which are based on mobile terminal as the teaching tools for moral education.

## 3. Research Route and Method

The research process, which is based on the theory of EDR, includes need analysis, game design, game development and testing. The research route of this study is shown as Figure 1.

As Figure 1 shown, the research is an iterative procedure by improving the need analysis, game design and development. In this process, we may return to modify our achievements to optimize the game design and program. The work will be carried out for many times until there is some feedback for the game.

Need analysis makes use of questionnaire survey and interviewing method, which includes pre-test of learners and teaching in elementary schools, the analysis of textbooks and syllabuses. After finishing the analysis of literature, the study prepares to design questionnaires and interview outlines to understand the situation and learning needs on moral education in elementary schools.

Game design is based on software engineering method to finish the work of instructional design, game scene design and script design. Instructional design is to make the learners understand the knowledge of morality by proper teaching mode and methods after completing the content analysis. And the game scene design will provide the layout of the game screen and the characters of the game map. At last, instructional design and game scene design should be transformed into scripts, so that a detailed storyline of moral game can be designed.
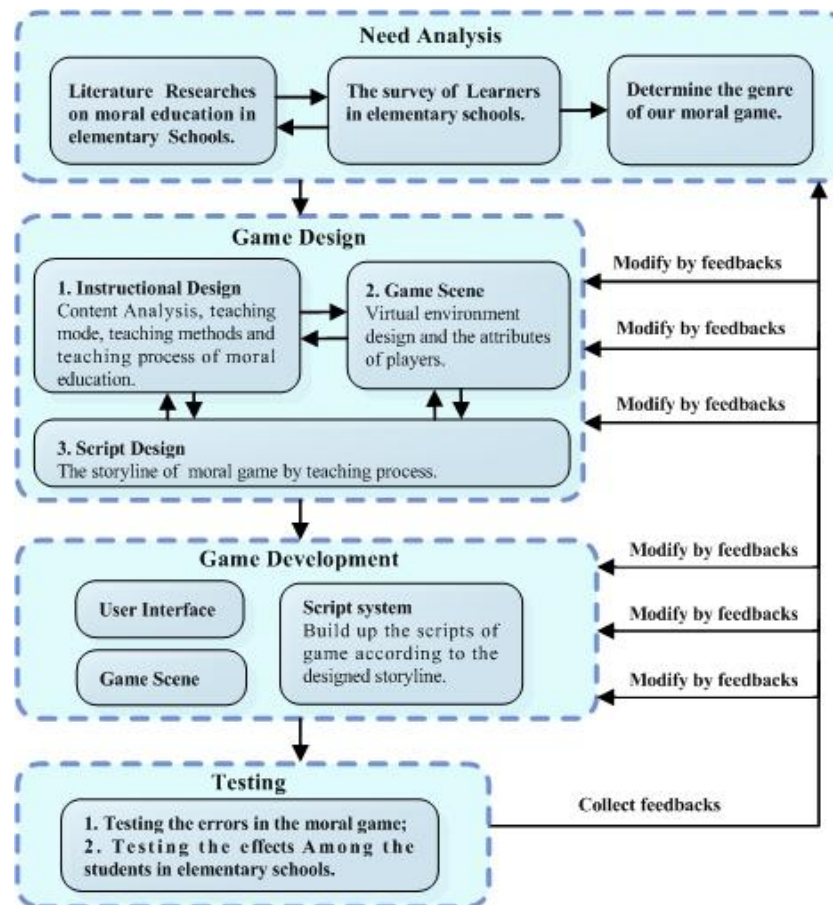
Figure 1.  The research route.

Game development also applies software engineering method. It includes user interface development, game scene development and script system. User interface development is to make the style, layout and events of buttons, images, labels and so forth. Game scene development mainly focuses on the maps, player character and non-player characters by the designed game scene. The script system will implement the storage of game data, tasks and characters.

Testing makes use of questionnaire survey and interviewing method to discover the bugs and problems of the game and collect the feedback from users after playing the moral game. According to the feedback of users and data analysis, the research will return to modify the achievements that we have finished.

### 4. Need Analysis

The research started with the pre-test in May, 2012 before designing and developing this game. A questionnaire was adopted to investigate the students from an elementary school, so that the teaching contents of the moral game would be helpful for students in elementary schools. The following collection and analysis of data is about the pre-test.

### 4.1. *Data collection*

The questionnaire of pre-test consists of 17 questions. The main purpose of the pre-test is to investigate the present situation of learning and teaching on moral education, the attitude toward the educational game and what kind of game the students want to play in primary schools.

The participants comprise 35 students, who are Grade 4, Grade 5 and Grade 6 students from an elementary school in Wuhan, China. Among the participants, the percents of the male and female are 51.43% and 48.57%.

### 4.2. *Data analysis*

The data obtained from pre-test were evaluated by SPSS computer program. For the data analysis, Multiple Response and the Independent Samples T Test analysis were used to evaluate the data, and significance level was 0.05. Furthermore, we designed some tests in the questionnaire of pre-test about the morality according to the textbooks of primary school. The correct rate of this test is 100% which suggests that the students have known the knowledge by schooling.

The forms of moral instruction in elementary school can be categorized as textbook, educational videos, instructional activity and educational game and activity, which can be described in Table 1. The percents of educational game and activity and instructional activity are 38.1% and 33.3%, all of which are higher than other forms.

To understand the difference between the gender of the samples and the attitude toward mobile phone games, the Independent Samples T Test analysis was examining the affect and the results were presented on Table 2. The results of the Independent Samples T Test show that there was a significant difference between the gender of the samples and the attitude toward mobile phone games ($F = 8.200$; $P > 0.05$). So the study requires more

Table 1.  Descriptive statistics relating to forms of moral instruction in elementary school.

| Item | Responses | | Percent of Cases |
| --- | --- | --- | --- |
| | N | Percent | |
| Taught by textbook | 3 | 4.8% | 10.3% |
| Watch educational videos | 15 | 23.8% | 51.7% |
| Instructional activity | 21 | 33.3% | 72.4% |
| Educational game and activity | 24 | 38.1% | 82.8% |

Table 2.  Levene's test of equality of variances.

| Gender | N | Mean | Std. Deviation | Std. Error Mean | F | Sig. |
|--------|---|------|----------------|-----------------|---|------|
| Male | 8 | 1.8333 | 0.78591 | 0.18524 | 8.200 | 0.007 |
| Female | 7 | 2.0000 | 0.50000 | 0.12127 | | |

questionnaires to investigate the difference between devices and the attitude toward the game.

To determine what kinds of games the students want to play and what kind of game the study should design and develop, the descriptive statistical analysis was used to present the proportion of kinds of game selected by students. Related graphics with the descriptive statistical analysis are shown in Figure 2.

The bar chart shows that 55.9% of students prefer to play the puzzle game, 29.4% like to play RPG (role playing game), and 14.7% want to play the sports game. According to the contents of the moral instruction, the puzzle games cannot make the students learn so much knowledge about morality. Therefore, the study chooses RPG to design and develop the moral educational game.

## 5.  Game Design

The game design consists of instructional design, game scene design and script design. The moral education is different from the other subjects, such as mathematics and physics. We believe moral games fall into two main categories, which are game library that contains a number of little games and role playing games. The design principles for moral games can be as follows:

(1) Clear operation. When starting the game, how, what and when you should do something must be clear. For example, if the player finishes a task, he must look at the messages and find relevant character to accept the next task. Operation may have
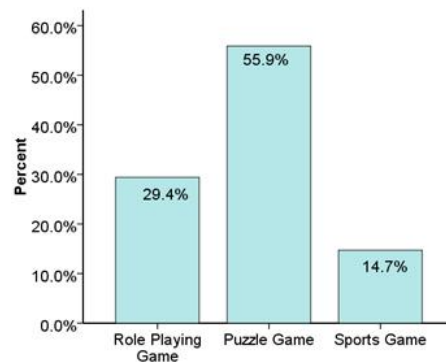


Figure 2.  Bar graphics for the percents of kinds of game selected by students.

bad effects on the learning if users don't know what they should do to play their game;

(2) Reasonable storyline. The storyline has a relationship with the game scene, so that the players can pay attention to the game. The process has the relationship with the real moral issues;

(3) Clear learning objectives. The game cannot present all the learning contents,  it should provide a learning-by-doing environment to inform users what they should achieve;

(4) Fun. The elements of entertainment may help students understand the moral contents more effectively;

(5) Characters' features. The player character and non-player characters should be recognized by clear attributes, such as occupations and names so that users can find the right character.

(6) Devices' features. Different devices have various operating modes. For the smart phone and tablet personal computer, the users can interact with the screen by fingers.

(7) Evaluation criteria. In the virtual world of games, it is competitive for players to learn and play. Many players want to evaluate themselves by some attributes, so that they can improve their learning.

## 5.1. *Instructional design*

Educational game, as an effective educational tool, plays a very important role in improving students' learning motivation and effectiveness (Yang & Wang, 2012). Begona Gros (2007) said digital games are user-centered, they can promote challenges, cooperation, engagement, and the development of problem-solving strategies. Thus, moral educational game design is a broad subject that contains different approaches and methodologies. Figure 3 shows the design ideas and methods.

Content analysis is to choose some suitable contents for the moral games, including
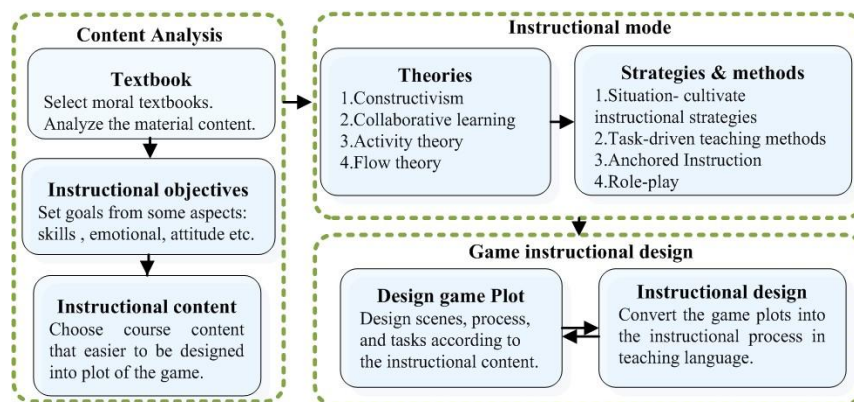


Figure 3.  The design ideas and methods.

the textbooks, instructional objectives, and instructional contents. The second part, on the basis of content analysis, tries to propose the appropriate instructional strategies and methods of moral education for the game. In the end, we design the game storylines and instructional design according to the contents and theoretical analysis.

This game is applied in moral education in primary schools. In this study, we select moral textbooks from third to sixth grades, and analyze the contents of textbooks in moral course. The contents in moral textbooks mainly include the following topics: protecting the environment, protecting public property, loving the beautiful motherland and hometown, respecting elders and so on. There are several characteristics of the moral teaching contents in elementary schools through the analysis of teaching contents:

(1) There is a close relationship between textbook knowledge and daily life, such as the unit in the textbook "I am a smart consumer" and consumers in daily life;

(2) The arrangement of teaching contents is based on the learners' psychological level and grades. Students in different grades learn different moral knowledge;

(3) Students can immediately apply what they learn in daily life;

(4) There are both procedural knowledge and conceptual knowledge in moral instruction. But the procedural knowledge accounts for most of the moral contents.

The essence of educational games is instruction, we cannot cart before the horse, "lose the watermelon and pick up the sesame" (Yang & Li, 2010). Instructional objective factor is what we must first take into consideration. We should design clear instructional objectives and instructional contents at the beginning of the game project. To simplify the approach to achieve instructional objectives and contents, we can design the objectives from the following several aspects: mastering basic moral knowledge, cultivating good moral quality, and learning to combine theory with practice. So we can select instructional objectives from the emotions, attitudes and values, according to learners' needs and zone of proximal development. The instructional contents in the moral game are designed according to the existing instructional objectives and are closely related to students' daily life, allowing students to develop good moral character in a virtual game scenario. In fact, the instructional content is a big task that is composed of smaller causally linked tasks. The learners must have the problem-solving ability if they want to master instructional contents. Games allow students to discover new ideas rather than memorize the material in the textbooks. The analysis of the instructional knowledge will be helpful to the choice of instructional model.

As we know, instructional mode is a comparatively steady teaching activity frame and activity program frame established under the guidance of certain instructional thought or instructional theory. But not all the teaching patterns are flawless and suitable to all students and teachers. For the teaching of science and mathematics, the dominant instructional mode is generally traditional, with presenting formal lectures. Instructional model that has been applied in the teaching of science and mathematics cannot adapt to the current moral teaching. The moral games must have their own instructional model, according to the type of game and the characteristics of teaching content. We learned that some instructional theories and instructional strategies and methods can guide the game

design from the literature reviews, such as constructivist learning theory, activity theory (AT), anchored instruction, task-driven teaching methods, role-play, and learning by doing and so on. In the game design, we can use a plurality of instructional strategies and methods to learn the same instructional contents. Constructivism means an exploratory approach to learning. The students can construct their own knowledge through cooperation and competition. Similarly, players can learn by doing in the moral game. There is a growing attention from the teaching procedure of "learning by doing" to the training and development of the personality of students. The experiential learning is a way through which learners can acquire knowledge by their experience, with an emphasis on "learning by doing, and doing by learning". The teaching procedure of "learning by doing" has its obvious feature and basic mode. Games provide complex environments in which contents, skills, and attitudes play an important role during the game (Begona, 2007). The game presents instructional contents mainly through the task, dialog, prompt box, scene and so on. For example, when the players learn the knowledge of waste classification, the players must participate in the process of sorting the garbage, and learn the knowledge of waste classification by doing in a virtual game scene. The situation-cultivates instructional strategies and task-driven teaching methods can be used in the morel educational game.

The use of stories in games is a fundamental part of game design (Rollings & Adams, 2003). Through educational games, the topics can be rendered more interesting and new concepts can be taught more easily, and information can be made more permanent (Naim, 2012). According to the instructional objectives, instructional contents, instructional theories and methods, we compile the instructional design for the moral game, and describe the storylines in teaching language. When the learners enter the game, the scene import shows the goal of learning task which lets learners study in situation. It stresses the key role of providing a social context that facilitates asking the right questions and going to the right places (Begona, 2007). Along with the continuous problems, learners complete their own knowledge structure in the process of solving problems. There are some questions to guide learners into the next task. The learners can rerun this task until they understand the knowledge. Then, they can proceed to the next question, or the next game task.

### 5.2. *Game scene design*

The situation teaching is an effective way to practice the moral instruction in elementary schools. Games are powerful contexts for learning because they make it possible to create virtual worlds, and because acting in such worlds makes it possible to develop the situated understandings, effective social practices, powerful identity, shared values, and ways of thinking of important communities of practice (Shaffer, Squire, Halverson, & Gee, 2005). The players should complete a certain task by the task-driven approach in virtual contexts. The virtual environment of the moral game should be designed according to the content analysis and instructional processes. The non-player characters can be designed as the teaching guides and instructors. In order to determine the style,

non-player characters and so forth, the study has some following suggestions on designing game scene for moral educational game:

(1) The style of the game scene is based on the teaching situation and process to determine the style of buttons, maps and characters. The moral contents are related to the real life and contexts, so our moral game scene should be designed as a community which includes modern streets, buildings, and characters;

(2) The non-player characters should have clear attributes to make the player understand them through their clothes, careers and dialogs. The attributes of non-player characters are better for the players to finish their tasks. In the moral game, the non-player characters are distinguished by careers, dialogs and tasks because the careers can determine what the characters focus on and the contents of tasks and dialogs;

(3) The attributes of player are the key points to make users evaluate themselves and finish the tasks when playing moral game. And the props in the game should have a relationship with the attributes of player and tasks. In this moral game, the attributes of player include level, gold coins, knowledge and conduct, which can be increased by relevant props and tasks;

(4) The device should be considered to understand how to interact with the game by users. The moral game will run on the mobile terminal, such as mobile phones and tablet personal computers, so there are some events which contain touching and dragging by fingers.

The main layout of user interface is shown as Figure 4. Users can see the attributes of player, tasks, message, dialogs and props by touching relevant buttons displayed in the game.

In this game, the value of gold coins, level and multiple kinds of animations will display directly on screen, and the game map is an isometric view so that it looks like a three dimensional game. The gesture of interaction with the game which runs on mobile terminal can be categorized as tap, long press, fling, pan, zoom, and pinch. The frequency



Figure 4.  The main layout of the game.

of tap gesture is much more than that of others which can display in the tasks and props. To keep the user experience better, the gesture design is based on following three principles to set the gesture onto the user interfaces and maps:

(1) The simple gestures include tap and long press, and the complex gestures involve fling, pan, zoom, and pinch.
(2) The user interfaces which will always display in the game scene should be manipulated by simple gestures, such as tap, long press;
(3) The user interfaces which will occur from tasks should be manipulated by complex gestures, such as fling, pan, zoom, and pinch.

The buttons and panels that display in Figure 4 should be manipulated by fingers frequently, so the simple gestures are the best way to control these user interfaces.

### 5.3. *Script design*

The educational game is a form of entertainment, even if it is for educational purposes, but also cannot afford to lose the game interest (Huang & Duan, 2009). The script design can keep the game more entertaining, and it consists of the game tasks, dialogs, reward mechanism and punishment mechanism. According to the instructional design, the teaching process is based on the task-driven approach, and the scripts should involve a number of tasks, relevant characters and rewards. In each task unit, the related characters can be recognized as the instructors and guides to interact with the player in a conversation. The main problem is how to set the difficulty of tasks so that the moral game is challenging and entertaining. For this moral game, this study summarizes two factors to control the difficulty of tasks - they are external factors (time, level and props) and internal factors (learning contents and forms of learning). In addition, the reward mechanism and punishment mechanism are rules of a virtual world which can stimulate students' interest in learning and make students understand the learning contents of morality. The ideas of script design can be as follows:

(1) Each task unit can be recognized as a learning process which can be found in the instructional design. And the conversations of the game are consistent with the instructional process in which the non-player characters can be designed as the teachers and guides;
(2) Reward mechanism and punishment mechanism should have a relationship with the attributes of player and props. The attributes of player and props vary from different learning processes;
(3) The tasks are not the only form of learning. The game should also contain a lot of small game to strengthen students' learning. For example, when a player is crossing a road in the game, there will be a traffic light to test the students what they should do;
(4) The game is not a linear process, and it should change by the choices and attributes of players, so that students will have different experience.

This moral game describes a kid's experience that he or she wants to help the residents in the community to make the society better. In the moral scripts, the occupation can lead player to find the right non-player characters and finish their tasks. The conversations should conform to the characteristic of the non-player characters' careers so that students can learn and play in real scenes of life. When a player is talking with the cleaner, they will talk about the contents on environmental protection. With the development of the game, the conversations will vary from different tasks and the structure of moral tasks is reticular formation, but all of the students will accept the same task finally to end the game.

In the task of waste classification, the player starts to accept the task from one non-player character and then finish the requirements to submit the task to another character. In order to finish the task of waste classification, the player should pick up all the rubbish on the streets and take an examination from the cleaner. The detailed script of waste classification can be seen in Table 3.

## 6.  Game Development

### 6.1.  *Development environment and structure*

The moral education game is developed to run on the mobile phone, tablet personal computer and other mobile terminal devices. The operating systems of these devices are mainly IOS, Android and HTML5. The prototype was developed using libGDX (a Cross-platform game development framework) with Eclipse as the authoring tool. The development environment and tools of prototype can be seen in Table 4.

Table 3. The script of waste classification.

| Task: waste classification |
|---|
| **Related characters:** Aunt Wang, the community director; Aunt Li, the cleaner in the community.<br>**Reward and punishment mechanism:** increase and decrease the value of coins, knowledge, level and conduct according to the amount of rubbish and the test of waste classification.<br><br>Aunt Wang: Hello, this is the community center, what can I do for you?<br>Player: Hello, Aunt Wang! The summer vacation will be coming; I want to be a volunteer of the community to help the residents.<br>Aunt Wang: Welcome to join in the community center. Now you are the member of community center.<br>Player: Thank you! But what can I do for the community?<br>Aunt Wang: Let me see. The cleaner tells me that there are a large number of rubbish on the streets, and they have bad effects on the life of residents. Can you help me to clean the rubbish?<br>Player: I am glad to help the residents; I will clean the rubbish immediately.<br><br>If the player has finished cleaning the rubbish on the streets, he or she can find Aunt Wang.<br><br>Aunt Wang: Thank you for your help! You are a good student. Now the cleaner Aunt Li has a lot of work to do, she is so busy. You would better to help her.<br><br>Talking with Aunt Li.<br><br>Player: Hello, Aunt Li! What can I do for you?<br>Aunt Li: There are many kinds of rubbish, I should put them into the different bins. Before doing this work, I will teach you about the waste classification and you can buy the books on classification.<br><br>On the screen, there will be a panel which contains three different rubbish and bins. The player should move the rubbish into the right bins by pan gesture.<br><br>Aunt Li: Thank you for your help! I will give you some rewards for your diligence. |

Table 4. Development environment and tools.

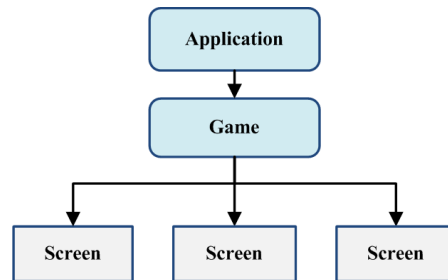| Development Environment and Tools | Purpose |
|---|---|
| libGDX | A Cross-platform game development framework; the game engine |
| Eclipse, Android SDK, ADT, Google Webkit | Make use of Eclipse to compile the Android HTML5 application |
| Tiled Map Editor | Game map edit tool |
| Lua | The environment of the game scripting system |
| LuaJava | A scripting tool for Java |

Figure 5.  Game application structure.

The libGDX codes were written in Eclipse which is used to develop the characters, maps, user interfaces and animations. The Lua is used to make the text script convert into Lua programming language, which can implement the game tasks, reward and punishment mechanism and characters' attributes. From the libGDX API (Application Program Interface), the structure of the game project in the eclipse could be defined by three layers. The application structure is as shown in Figure 5.

The application layer is the entry point of the game that can use the packages of Android, webkit or Lwjgl. The game layer can be implemented by the class called "Game" in libGDX. The screen layer will show the game graphics, such as the buttons, texts, character, and so forth. A game layer can manage many screens that can be defined by interface called "Screen" in libGDX. And the "Game" class has the method called "setScreen" to make the current screen switch to another.

## 6.2. *User interface development*

The interface of the moral education game includes a main menu, a game play screen, a loading screen, a help screen, a settings screen and a game over screen. The game structure of user interface is as shown in Figure 6.
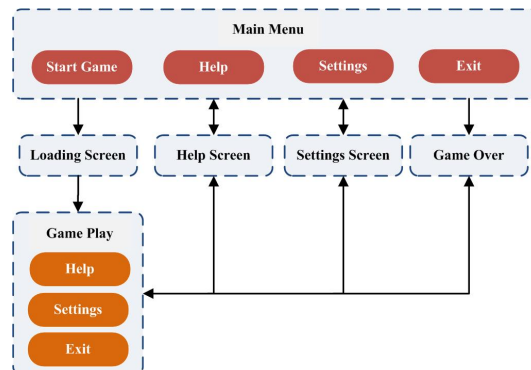


Figure 6.  Game operational process of user interface.

The game starts with the "Main Menu" screen, which can enter the "Loading Screen", "Help Screen", "Settings" and "Game Over" by touching the relevant buttons. However, the "Loading Screen" will automatically switch to the "Game Play" without touching after finishing loading the game resources.

According to the game operational process, applying the interface "com.badlogic.gdx.Screen" of libGDX to create six game screens, and making use of the package "com.badlogic.gdx.scenes.scene2d.ui" of libGDX to implement button, dialog, label, table and other complex game interface. The parts of the game user interface are as shown from Figure 7 to Figure 10.

Many of the game user interfaces are made up of more than one kind of class of the package "com.badlogic.gdx.scenes.scene2d.ui" in libGDX. For example, the "Book list" panel consists of "Image" class, "Label" class, "Button" class and "Table" class in libGDX, all of which can be found in the package "com.badlogic.gdx.scenes.scene2d.ui".

To make the game user interface be controlled by players, libGDX provides the events (touch, drag and long press), that can be added to the "Image" class and "Button" class in this game. For example, in the waste classification panel, the image of the



Figure 7.  The interface of task and attribute.



Figure 8.  The interface of waste classification.



Figure 9.  The interface of bookshop.



Figure 10.  The interface of player character's pack.

rubbish should be added on the drag event from libGDX. And the rectangular collision detection can be added among the rubbish images, dustbin images and the whole panel. So when dragging the rubbish image by finger, the rubbish image will move within the waste classification panel. However, in the book list panel, the button can be added by click event, so that players can buy books by touching the button. Moreover, the main class of the task interface can be applied by the "Window" class from libGDX, which has the potential function of moving within the screen by dragging.

### 6.3. *Game scene development*

The development of the game scene includes the development of the game map, player character and non-player character. The development process of the game scene is as shown in Figure 11.

The game map is the basis of the whole game development. The development of the game map mainly involves following work: editing the game map images and building the game coordinate system. The game map is an isometric view by tile based approach, so that it looks like a 3-dimensional game scene. The objects (ground, houses and trees and so forth) can be displayed by kinds of tiles. Each tile can be designed by the aspect ratio of 64 pixels and 32 pixels. The tiles would be imported into the "Tile Map Editor" to build up the roads, shops and so forth. The screenshot of the map image edited in the "Tile Map Editor" are as shown in Figure 12 and the game scene is as shown in Figure 13.

In the "Tile Map Editor", the map would be divided into four layers or more, that is background, under, over and collision. After editing the game map, the "Tile Map Editor" could export four integer arrays in which a tile can be represented by a number. And the libGDX has the rendering methods to show the map by the four arrays and build up game coordinate by defining the array of background layer.

The player character would not be edited in "Tile Map Editor". The first work is to design player walk sheet of eight directions. And then, creating a new class called "Character", which would extend the class "com.badlogic.gdx.graphics.g2d.Sprite" in
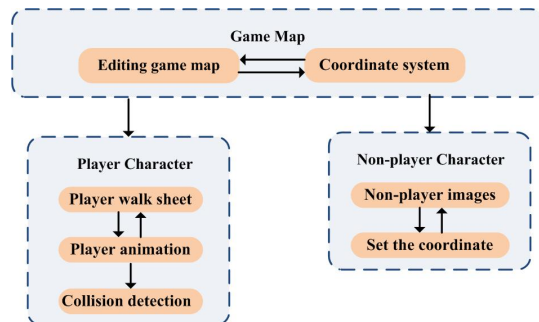


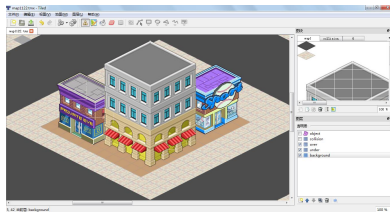Figure 11.  The development process of game scene.

Figure 12. The game map in Tile Map Editor.



Figure 13. The game scene.

libGDX. The "Character" class would make use of "com.badlogic.gdx.graphics.g2d.Animation" in libGDX to implement the walking animation. However, in order to implement collision detection for the player character, the walking animation should combine with the array of collision layer. By calculating the x-axis and y-axis coordinates of the next tile that the player will walk on, the game will return relevant value of the array. If the value of the array is not 0, the player character cannot walk onto the tile.

The implementation of non-player character could follow the methods of the development of the player character. The image of the non-player character could not have a walk sheet of eight directions. Furthermore, the non-player character's position in the map can be determined by the tile based coordinate system.

### 6.4. *Script system*

The script system of the game can store the data of the task, map, message, player character and non-player character. According to the designed scripts, the game process is based on the tasks, and the player character has a variety of attributes which can change by finishing the tasks. The structure of the script system can be as shown in Figure 14.

The public script, player script, task script, message script, map script and non-player script have their own script files. The public script has the common information of the game, such as the game state (dialog, walk) and the progress of the game. The player script defines the attributes of player character, which includes money, level, knowledge, and behavior. And the player script has its own methods to change these attributes. The task script includes a lot of information about a task. For example, the task of waste classification has the information of identity, the receiver of the task, the sign whether the task is accepted, the sign whether the task is finished, the number of the rubbish that the player has picked up and the prize for this task. The message script is to display the task information so that the player can find relevant non-player character to receive the task. The map script includes the map names (outside, bookshop, and so forth.) and the non-
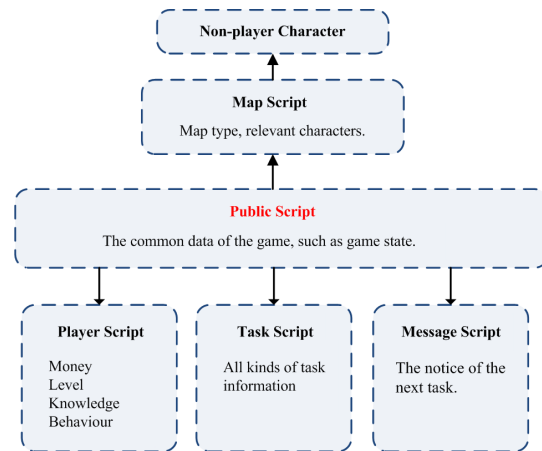
Figure 14.  The structure of script system.

player script objects. The map script can define where the non-player character should be placed. So when we enter into the bookshop, there is only one non-player character (book seller). At last, the non-player script has the dialog texts, name and its own method to promote progress of the dialog.

The script system of the game is compiled by the Lua programming language. It can reduce the amount of Java codes, and be much more efficient if translating the designed scripts into programming language. In order to implement the interaction of Java and Lua, the scripting tool for Java called "LuaJava" should be imported into the game project that allows Java components to be accessed from Lua, and also allows Java to implement an interface using Lua.

### 6.5.  *Algorithms of path finding*

When starting the moral game application, we would consider how to control the player to reach a destination by touching the screen of a tablet personal computer and a smart phone. There are two ways to implement the path finding of player, which are on-screen joystick and the path finding algorithm of artificial intelligence. To keep the user experience better, the moral game applies the path finding algorithm to make the player move in the game map by gesture.

The path finding algorithm of the game can apply A-star algorithm of artificial intelligence. The formula of A-star algorithm follows the equation:

$$F = G + H. \tag{6.1}$$

*G* means the movement cost to move from the starting point to a given grid, following the path generated to get there. *H* represents the estimated movement cost to

move from that given grid to the final destination. The steps of the algorithm are as follows:

(1) Putting starting point into the open list;
(2) When the open list is not empty, repeating the following steps:
   (a) Acquiring the minimum F of the point from the open list, then deleting this node, and putting it into the close list;
   (b) Checking all neighboring points, and calculating the F values.
   (c) Putting head point into the close list;
   (d) Putting all neighboring points of head point into the open list.

## 7. Testing

The testing of the game includes multiple stages until there are few mistakes in the game application. The feedback of users could be obtained by interviewing method. The instructional design, scripts, and game demo have been modified by the evaluation. The game has not yet been applied to instruction in elementary schools, so the game is tested by the group members of the research and other graduate students. A questionnaire was adopted to collect the feedback after the users played the moral game. The participants comprised 20 students, and 18 questionnaires were available. Our goal was to find out the errors and improvements in the instructional content, user experience and process. The feedback and items of users are as shown in Table 5 and Table 6.

Table 5. Feedback and items of game content.

| Items | Options | Percent |
|---|---|---|
| Which form of teaching content presented in the game is most helpful to you to learn morality? | The teaching content presented in dialog. | 33.3% |
| | The teaching content presented in game props. | 22.2% |
| | The teaching content presented in game tasks. | 44.4% |
| In the script system, what do you think should be improved? | The objectives displayed in tasks are not so clear. | 25.6% |
| | The NPC (non-player character). | 20.5% |
| | Incentive mechanism. | 23.1% |
| | The difficulty of the task. | 23.1% |
| | Others, such as highlighting the position of NPC. | 7.7% |
| What problems can be presented in the dialog? | Too lengthy dialog. | 24.0% |
| | Dialog failed to express characteristics and emotions of NPC. | 24.0% |
| | Dialog failed to contain learning content. | 32.0% |
| | The information conveyed by dialog cannot express correctly. | 8.0% |
| | Others, such as statement error. | 12.0% |

Table 6.  Feedback and measures of user experience.

| Items | Options | | | | |
|---|---|---|---|---|---|
| | Very helpful | Helpful | General | Little help | Not helpful |
| Can the attributes of player stimulate your interest in learning? | 33.3% | 50.0% | 16.7% | 0 | 0 |
| Can the scenario of tasks stimulate your interest in learning? | 83.3% | 11.1% | 5.6% | 0 | 0 |
| Can the props make you happy when playing the game? | 5.6% | 61.1% | 22.2% | 11.1% | 0 |
| Can the messages and navigation system help you finish the tasks? | 16.7% | 44.4% | 33.3% | 5.6% | 0 |

As shown in Table 5 and Table 6, the tasks displayed in the game could be most helpful to users to learn morality. Maybe the task-driven teaching is better for the moral education by game-based learning. But the objectives, incentive mechanism, dialog and difficulty should be modified to make them clear and challenging. Moreover, the data about emotion and performance when playing the game are shown in Figure 15 and Figure 16.

The bar charts show that 61.1% of users feel happy when getting the rewards and praise of NPC, and 38.88% of users think this mechanism has no effects on them. The frequency of buying props shows that the game props have little relationship with the tasks and player character, and most of users could not buy the props to finish their tasks.

In addition, we also collected some feedback by users to describe the problems occurred in the moral game, the feedback can be described as follows:
(1)  The difficulty of the game should be increased, and some tasks are easy for users to finish.
(2)  It is better to make the NPC move in the game;
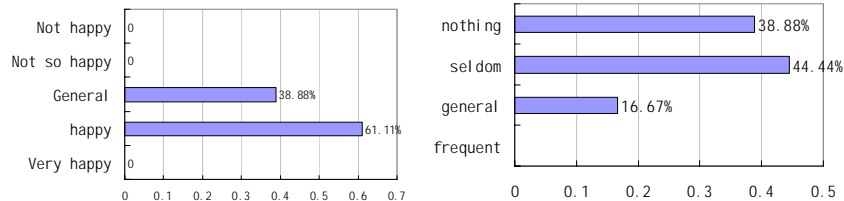(3)  There should be some tips in tasks to inform users what they are to do.



Figure 15.  The emotion when getting the rewards.   Figure 16.  The frequency of buying the props for tasks.

(4)  The navigation should make the users understand their position in the game map. Maybe there should be a little map to make users find the right NPC clearly.


After the data analysis of testing, the design and development are based on the task-driven teaching, and we have measures to settle the problems for the tasks, navigation, rewards, NPC and so forth. The comparison charts of modifications are shown from Figure 17 to Figure 20.

This game is based on a number of tasks, and the player character of this game have attributes of money, level, knowledge and character. In addition, the books are designed to act as one kind of the game props. If the players read the contents of these books, the knowledge value will increase by relevant number. In addition, the interface of message



Figure 17.  The game screen before testing.



Figure 18. Adding the interface of task.



Figure 19.  Adding the interface of attributes.



Figure 20.  Adding the books.

Figure 21.  The screenshot of this game running on the mobile phone of Android.

is added to notice the information about tasks, so that the players can find and receive the next task timely. The message has the function of navigation so that players can find the right NPC and understand the direction of the game map. The final production is shown as Figure 21.

## 8.  Discussion and Conclusion

This study is a moral educational game for primary school students. At the beginning of the design, the team members have completed the following work:
- Analysis of students' demand through the questionnaire survey;
- Design the instructional design of game according to moral content analysis, the teaching mode and methods and designed storyline;
- Finish the development of the moral game based on instructional design;
- Complete the design and development of the moral educational game.

   The authors of the paper have just finished the design and development of this moral educational game, accomplished the moral game application according to the questionnaires that are collected from an elementary school. So our future work is as follows:
- Transplant the game to the mobile devices installed operating system in addition to the Android;
- Test the effectiveness of the game in moral education by some questionnaires and experiments from elementary schools;
- Improve game application in teaching so that the students want to learn and play;
- Design some tests and modification plans according to feedback.

   Educational games provide a new teaching method and change the traditional way of learning, with broad prospects for development. Educational game design is the foundation of development and promotion of the game, which can make the instructional contents of games reasonable. In addition, The EDR theory suggests that the educational game should have multiple stages to modify and improve the achievements, so that the application and design could be optimized. Moreover, the multiple stages maybe focus on different problems by feedback and evaluations.

In short, the design and development of educational games are a comprehensive and complex process. In order to achieve the meaningful learning, we should take a broader perspective to introduce the related theory to consider the design and development, according to the students' learning characteristics and instructional contents.

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