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Save the forests: A pilot study of a role-playing game for environmental education

Ming-Chaun LI[a*], Huei-Tse HOU[a], Yi-En KUO[b], Kai-Hsiang YU[b] & Cheng-Han YANG[b]

[a]*Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology, Taiwan*

[b]*Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan*

[*]mli1tw@gmail.com

Abstract: The purpose of this study was to explore the potential of a PC-based role-playing game for teaching the subject of forest preservation. Four elementary students participated in this case study. The observation and interview were implemented to collect their gaming behaviors and feedbacks about the perceived ease of use, perceived usefulness, and the design elements of the game. The results showed that students viewed the game as an easy and useful learning tool that fulfilled major game characteristics. Suggestions were proposed for the design of the game and future research.

Keywords: Game-based learning, role-playing game, RPG, environmental education, forest preservation

1. Introduction

What makes role-playing game (RPG) attractive is that it provides a unique space where players play the game through the eyes of a game character to experience the virtual world following the storyline of the game. Role-playing has been viewed as an important strategy that allows students to learn a complex issue from different perspectives by playing different roles [2]. Combing with gaming environment, the RPG can be a fun and situational context that engages students to practice given roles embedded with diverse knowledge and values. Currently, the popularity of massively multiplayer online role-playing game (MMORPG) has drawn researchers' attentions to explore its potential for learning [4]. Unfortunately, it is difficult to develop an educational MMORPG with limited budgets, people, and time in educational context because of its complexity of design. On the contrary, a single-player PC-based RPG will be easier to develop by using game authoring tools. Also, it might be easier for teachers to integrate a PC-based RPG to their curriculum because of its limited scale and easy management of students' learning. Even without providing interactions among players, a PC-based RPG that featured with storytelling, premise of the fictitious reality, and narrative experiences can still engage players to the game context and the role they play [5, 7]. However, the potential of using PC-based RPG for learning seems to be overlooked. It is necessary to examine the feasibility and effectiveness of employing PC-based RPG as a learning environment.

With the increasing destroy and threats to the natural environment, how to protect it and achieve sustainability become a critical issue all over the world. The curriculum guidelines of environmental education (EE) for primary schools in Taiwan stress the need for students to understand the relationship between human and the environments, and to develop appropriate attitudes, values, and actions toward the environments. However, most of the content provided in the textbook is factual knowledge with limited scope and provided to students usually by lecturing. Students might be able to remember some factual knowledge but whether they can connect the knowledge to their daily life and develop

adequate values and attitudes are remained questionable. As stated by researchers, role-playing that combined with a simulation or a game could present students with an authentic and situated learning environment that promotes students' understanding of knowledge and values from multiple perspectives [6]. With the attractive feature of fantasy storyline, RPG might be a good way to motivate students' learning and make learning relevant to their life both in knowledge and attitude. In this study, a PC-based RPG was developed for environmental education, specifically on forest preservation which is closely related to our lives. The purpose of this study was to pilot test the game empirically and evaluate the degree of acceptance and design factors of the game.

2. Methodology

2.1 Participants

Four elementary students voluntarily participated in this pilot study. Because the game was originally designed for 3rd to 6th grade elementary students, participants across different grades were recruited to test the game. The background information of these participants is shown in Table 1.

Table 1. Background information of the participants

	Player			
	1	2	3	4
Gender	Female	Female	Male	Male
Grade	6	4	5	3
Age	12	9	11	8
Game experience [a]	Moderate	Moderate	Experienced	Inexperienced

[a] The students' game experience was identified based on their own descriptions of game playing history and frequency during the interview.

2.2 Research Design and Procedure

This study employed a case study design to test the feasibility of a self-developed educational game. Observation and interview were conducted to collect individual student's game playing process and feedbacks.

The parents of these students were informed the aim of the study first and the students were arranged to play the game individually. Before they started to play the game, each student was given a short instruction of game operations. The playing process of each student was observed and noted in details including time spent and reactions toward dialogues and attacks. Students were expected and encouraged to complete the assigned game tasks by themselves. Assistance was only provided when students had difficulties to continue the tasks. After each student achieved the game tasks, an interview was conducted to assess students' learning outcomes as well as collect their opinions about the game.

The main interview questions were divided into three parts to evaluate "perceived ease of use," "perceived usefulness," and "game design elements." The first two parts were based on the Technology Acceptance Model (TAM) [3] and the third part was drawn out from the essential factors of game design illustrated by Alessi & Trollip [1]. The interview structure and example questions are listed in Table 2.

Table 2. Interview structure and example questions

Structure	Description	Example Questions
Perceived ease of use	Students' perception about whether it is easy for them to play the game.	Do you think you went smoothly in the course of the game? Did you encounter any difficulty during the course?
Perceived usefulness	Students' perception about whether the game could help them to achieve learning goals.	Did you learn how to protect forest before? Does this game help you to learn (more about) how to protect forest? What are the ways to protect the forest that you learned from the game?
Game design elements	Students' feedbacks toward each element. The elements include goals, rules, competition, challenge, fantasy, and entertainment.	Do you think the game is challenging? What do you think about the degree of the challenge (too difficult, appropriate, or too simple)? Please describe briefly about the challenges you faced in the game and to what degrees the challenges were.

2.3 Game Description

In this study, an authoring tool – *RPG Maker™XP* – was used to develop a PC-based RPG named *Forest*. The game was designed for 3rd to 6th grade elementary students. The only pre-requirement of the players was basic level of Chinese reading ability.

Both gaming and learning aspects were taken into account when the game was designed. First, to immerse students in a situated learning context, a background story was provided at the beginning of the game:

"Forest" is a wizard kingdom of the trees that coexists with human world since ancient times and provides rich woods resource for human life. However, with the increasing demand of woods by human, the woods resource has been overused. While the forests are excessively destroyed in human world, the Glory Tree that supports the life of "Forest" is dying at the same time. The elder elf foresees that the "Forest" will cease to exist in one year. When that happens, human world will be vanished too. The only way to avoid this disaster is to bring back Green Leaves from human world to save the Glory Tree.

In this game, the participants played the role of Essen, who was born to save the "Forest" and human world. Essen was accompanied by Green Wizard to carry out the tasks (i.e., finding Green Leaves in human world). Green Wizard was set to follow Essen's movements automatically. When encountering attacks, a player could control Essen and Green Wizard separately to make a fight.

Second, the content and tasks were designed for students to gain knowledge about forest preservation by achieving the game tasks. Mechanisms of task guiding and task performing were employed to facilitate students' learning. In RPGs, text-based communication is the main channel for players to get information and task guidance. Two types of communication were adopted in this game: one-way knowledge delivery and interactive dialogue (see Figure 1). When the former one was used, the whole piece of learning content was displayed directly in the text box. For example, "*Some people call the forest 'lungs of the Earth' because the trees will absorb large amounts of carbon dioxide for photosynthesis to produce oxygen and to help regulate the temperature of the surface environment*." When the latter one was applied, the learning content was embedded in the dialogue that players would have to obtain the information by conversing with non-player characters (NPCs). The example is as following.

Essen: *Excuse me, sir! What can we do to protect trees from being overused?*
Expert: *Well ... I would advise you to reduce the demand for wood.*
Essen: *How to do that?*
Expert: *For example, we do not have to always buy new furniture or wooden items. I like to help my neighbors to fix their wooden furniture so that they can use it for a long period of time.*

(a) (b)

Figure 1. The screenshots of text-based communication: (a) one-way knowledge delivery; (b) interactive dialogue.

The first reading of each learning unit would be rewarded with experience points that could help increase the level of the game character. The mechanisms of task performing defined the actions needed to achieve the tasks. The matching learning goals, game goals, and mechanisms of *Forest* are listed in Table 3.

Table 3. The design of learning mechanisms

Learning Goals	Game Goals	Mechanisms	
		Task Guiding	Task Performing
Learn basic knowledge about forests			
-Functions	Find "Knowledge Palace" in "Forest". Hit and read all items that embedded with target knowledge so that Essen and Green Wizard can go to the human world to find Green Leaves. (Required task)	One-way knowledge delivery	Find places & Hit items
-Elements	Talk with NPCs in "Forest" to learn about anion and phytoncid. (Optional)	Interactive dialogue	Meet NPCs & Activate dialogue
Learn applied knowledge about protecting forest resource	Build a resource center in human world by inviting three experts to work in the center, and then talk to key NPCs to find a Green Leaf. (Required task)	Interactive dialogue	Find NPCs following directions & Activate dialogue
	Talk with NPCs to learn more about the ways to save forests. (Optional)	Interactive dialogue	Meet NPCs & Activate dialogue

Third, enemy attack was built in the game to provide challenging and exciting experience for students as well as connections with learning goals. Most of the attacks were invisible and triggered randomly by the system. The enemies were either tools or machines that would destroy the forests (e.g., axe, tree-cutting robot, fire-spraying robot, paper-eating machine) (See Figure 2). Fighting with the enemies meant saving the forests. In addition, anion and phytoncid were designed as items that players could collect by winning the fights or from treasure boxes. The mechanisms of anion and phytoncid in the game were similar to their functions in real world that players could use anion and phytoncid to supply blood (i.e., life) and power (i.e., energy) of Essen and Green Wizard respectively.

Figure 2. The screenshot of fighting with a tree-cutting robot in the forest

3. Results and Discussion

3.1 Overview of game playing process

An overview of each student's game playing process is illustrated in Table 4.

Table 4. Overviews of the students' game playing process

	Player			
	1	2	3	4
Total Playing Time (min.) [a]	91	105	94	96
Number of Failures [b]	1	0	2	0
Interaction with NPCs [c]	38 of 48	36 of 48	42 of 48	41 of 48
Battle Frequency [d]	51 of 58	38 of 68	55 of 65	20 of 59
Needed Assistance	Direction	Direction Task Operation	Direction Task	Direction Task Operation Attack

[a] The rest time during the game was not calculated.
[b] The number of "game over" occurred when the main characters failed to survive from the attacks.
[c] The number of NPCs activated by the players among all NPCs.
[d] The number of fights executed by the players among all triggered attacks.

The average time of game playing is 96.5 minutes. The observation showed that all students were attracted to "talk" to more than 75% NPCs in this gaming context. This indicated a great possibility to deliver learning content through NPCs. Generally speaking, students could complete the game tasks without replaying the game too many times. However, all of them need assistance to some degree in different aspects. All students faced

some problems of finding right directions to the target places. Task-related clues were also provided to most of the students when they did not know what to do in the next, forgot the task, or missed key NPCs or items. It was observed that the younger the students were, the more the frequency and types of guidance were needed when they played the game for the first time.

3.2 Perceived Ease of Use

All students agreed that the game was easy to operate and play. It was also easy for them to get familiar with the game except Player 4, who had the least game experience among the four students. It was obvious from the observation that Player 4 needed more help in finding target places and items, and took longer time to learn the fighting mechanisms.

3.3 Perceived Usefulness

Students' perceptions about usefulness of the game are reported in Table 5. All the students were also asked to recall as much as they could about the knowledge they learned from the game. Player 4 was a special case that he did not perceive the game as useful in all knowledge learning. As stated by Player 4, he remembered seeing the information somewhere in the game but he did not learn the knowledge. The following analysis was based on the rest of the students.

The basic knowledge about forests was embedded in the "Forest" that students would learn from the first half of the game. Students perceived usefulness differently when learning basic knowledge. All three students had learnt functions of the forests previously and thought the game would help them to enhance formerly studied knowledge and learn new one as well. However, only Player 1 and Player 3 could recall two of the six functions roughly. As for learning the knowledge about elements (i.e., anion and phytoncid), only one student thought the game was useful. Yet, all three students could recall the gaming functions of the elements used in fighting.

Table 5. Students' perceived usefulness of the game to achieve learning goals

		Player			
Learning Goals		1	2	3	4
Basic Knowledge					
Functions	Prior Knowledge	Yes	Yes	Yes	No
	Usefulness	Yes	Yes	Yes	No
Elements	Prior Knowledge	No	No	Yes	No
	Usefulness	No	Yes	No	No
Applied Knowledge					
Forest protection	Prior Knowledge	Yes	Yes	Yes	No
	Usefulness	Yes	Yes	Yes	No

Students were set to learn the applied knowledge about forest protection after they entered the human world. These students talked to most of the NPCs whether those were required or optional ones. They all agreed that the game helped them to learn more about the ways to save the forests. All of them could recall the basic concepts of this applied knowledge such as reuse of the paper and wooden products. It was found that Player 1 could remember the most of the application methods while Player 3 could sometimes describe the learning dialogue in details in addition to recall of those methods.

The above findings suggested that students who were elder or had more game experience could benefit more from this role-playing game. This might be because they had

better reading comprehension, or they could pay most of their attention on learning content instead of making effort to get familiar with the game itself. Moreover, students could recall more learning content when they were reminded with specific context in the game. This indicated that this role-playing game could enhance students' learning by connecting learning to a situated gaming context.

In sum, three of the four students stated that they would be motivated to learn more about forest preservation in the future because of this game. Students who mentioned learning useful knowledge from the game also stated that they would apply the knowledge learnt in their daily life.

3.4 Game Design Elements

According to the feedbacks from the students, the game tested in this study had clear goals and rules, provided competition and challenge, and satisfied the expectation of fantasy and entertainment. However, among these elements, students' views about competition were different from what was expected for the design. In this game, the competition came from the attacks of enemies. Only one student (Player 2) thought the amount of attacks was appropriate while the rest of the students felt the attacks happened too frequently. However, the data in Table 4 showed that Player 2 decided to run away from about half of the attacks. She stated that the completion of the tasks was more important than winning the fights to get items. It was also interesting to notice that among students who thought being attacked too often, Player 1 and Player 3 still chose to fight with most of the attacks because they wanted to collect more items and checked whether their special fighting skills were increased. On the contrary, Player 4 escaped from more than half of the attacks because he thought it was a waste of time to fight and he did not want Essen to lose blood. The findings indicated that frequent attacks would disturb younger students' gaming and learning process that might cause negative impacts on their learning achievements.

When considering the challenge aspect of the game, it was too simple for experienced player (Player 3), too difficult for inexperienced player (Player 4), but appropriate for students who had moderate game experience (Player 1 & 2). A common challenge for all the students was finding target places or NPCs in a large scene which could not be overviewed in the game window. As observed in their playing process, students were often stuck in the scene before getting some guidance from the researcher. The challenge was even greater for Player 4 that he mentioned the text was too much to read and he had problems of understanding some of the words.

4. Conclusion

The purpose of this pilot study was to explore whether this educational PC-based RPG could help students achieve the learning goals by providing a situated and motivating learning environment for students. The findings indicated that in general, these students reported positive experience of playing and learning in this game. This game was showed to fulfill major game characteristics as stated by Alessi & Trollip [1]. In addition, the game was viewed by the students as an easy and useful learning tool. According to TAM [3], the potential of this game to be accepted for learning was granted. Moreover, the learning of the students seemed to be promoted by this situated gamine context.

Based on the results of this preliminary study, several suggestions in relation to learners' characteristics, game design, and research design were listed as follows:

- *Learners' characteristics:* Reading comprehension might affect learning effectiveness especially for younger students when the learning content was mainly delivered by text format. There is a need to make the reading easier or use other formats of knowledge

representation to enhance the learning of younger students. In addition, previous game experience might also be an important factor to influence students' learning in a RPG that needs to be explored in future studies.

- *Game design:* The results suggested a possibility that students would learn more from interactive dialogue than from one-way knowledge delivery. Future studies will be needed to control possible confounding variables to examine the learning effectiveness of different mechanisms of text-based knowledge delivery in RPGs. To overcome the problem of disorientation in a large scene, a thumbnail could be adopted to help students find target places. Moreover, the design of attacks will need to be adjusted in frequency and mechanism to provide exciting competition without impeding the learning process.
- *Research design:* In this pilot study, all students were only given one chance to play the game. Even though two students needed to re-enter the game after losing the fights, they started the game from the locations they were failed instead of starting from the very beginning. As it was observed, students took about more than one and half hours to complete the game and they all felt tired to some degree during the process. The lack of flexibility for students to decide their playing time and paths might cause the inefficient learning outcomes of a lengthy game, especially for younger students. There are two possible solutions to overcome the problems. First, shorten the length of the game by reducing the scale of the scenes and the frequency of attacks but save all the learning content in the game. How to keep the game challenging and competing will be the issue to consider. The second solution is to allow students to play the game in their own paths and patterns within a given time range. By doing this, methods to collect data sufficiently and efficiently from individual computers will need to be carefully designed.

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