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Learning Application with Collaborative Finger-Touch Game-Based Learning - A Study of iPad app in Mathematics Course

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Abstract: Constant advancements in technology come innovation and changes in learning methods for students. Specifically, the combination of a multi-touch interface and the game-based learning method has been found to increase the fun experienced by students during the learning process, their motivation to learn, and their willingness to participate. In this paper, we used a finger-touch game, an iPad app called Math Frogger to help students learn and put into practice the mathematical concepts of addition, subtraction, multiplication, and division. Three game scenarios were proposed and investigate whether these scenarios were able to affects the flow experience, motivation, satisfaction, and learning performance of students and to observe whether the aforementioned four variables under the various scenarios would lead to different learning outcomes.

Keywords: Collaborative learning, game-based learning, human-computer interaction

1. Introduction

Multi-touch technology has become widely available for human-computer interaction and has, in turn, promoted the awareness of human-to-human interaction, more than awareness of personal computers, in colocated collaborative work (Hwang et al. 2011). Using a multi-touch interface in educational settings may help students to become actively engaged in game-based learning activities (Ardito et al. 2013). Researchers have found that students preferred the learning experience with an iPhone game (with multi-touch interface) over traditional games (without multi-touch interface) (Furio et al. 2013). However, more studies are needed to establish that multi-touch games in collaborative learning settings are able to promote student learning.

Recently, an increasing number of teachers have endeavored to integrate educational computer games into training and teaching (Furio et al. 2013; Roblyer 2006), because computer games are perceived as an effective means to help students gain knowledge (Wang and Chen, 2010). Educational computer games have been suggested as an intrinsic motivational tool that encourages interest and enables learners to control their own learning (Dickey 2007; Huizenga et al. 2009; Papastergiou, 2009). Previous studies have indicated that computer games can entertain, instruct, change attitudes, and develop the skills of students (Alessi and Trollip, 2001; Hwang, Wu and Chen, 2012; Sun, Wang and Chan, 2011). Digital games can support and strengthen learning in four dimensions: school achievement, cognitive abilities, learning motivation, and attention and concentration (Rosas et al., 2003).

Recent research (Admiraal et al. 2011) has indicated that collaborative game-based learning can provide a flow experience. The concept of flow is used as a framework to investigate student engagement in the process of gaming. Admiraal et al. (2011) found that the flow state has an effect on the game performance of students, but not on their learning outcome. Sung and Hwang (2013) pointed out that collaborative game-based learning improves students' self-efficacy and also enhances learning effects. The games are used in mathematics training and teaching courses. However, little research has examined whether multi-touch games in a collaborative-learning setting affect the flow experience and learning outcome of a mathematics course. Therefore, the purpose of this study was to make use of a

multi-touch game (*Math Frogger*, an iPad app) in a collaborative-learning setting, to investigate its efficacy for science and technology and the flow experience and learning performance of students in a mathematics course.

2. Theoretical Background

2.1 Collaborative Learning

Collaborative learning not only allows students to learn how to respect others, but also helps in improving learning performance (Kuo, Hwang, and Lee, 2012; Schellens and Valcke 2005). Collaboration and brainstorming can assist students in the collaborative learning group to receive an enormous amount of information efficiently, thereby helping them to generate new ideas in order to accomplish learning tasks (Lipponen, 2002). Therefore, researchers have pointed out that while improvements in student learning can be achieved by using new technology, collaborative learning methods should be used to help students develop skills for their future careers as well. In the past few years, scholars have conducted relevant research on collaborative learning and educational computer games. For example, Delucia, Francese, Passero, and Tortora (2009) have conducted experiments in universities within this learning environment in order to assess second life synchronous distance lectures. Their experimental results showed that synchronous communication and social interaction were fully supported within the virtual environment. In addition, both tutors and teachers pointed out that social interaction is the true motive of students.

Huang, Liu, and Wu (2011) pointed out that in comparison with conventional methods, learning systems that included cooperative and collaborative online games significantly improved learning performance. Admiraal et al. (2011) conducted a study within the context of collaborative game-based learning. The study involved a total of 216 participants and their flow experience was investigated through team game activities, while the game was applied in the learning of history. The results showed that flow experience influenced student performance in games, but did not influence their learning outcomes. Hummel et al. (2011) investigated how learning outcomes can be enhanced in the process of playing games by including the concept of collaboration. They found that the quality of learning outcomes can be enhanced using collaborative game-based training. Further, Sánchez and Olivares (2011) presented their results on a series of learning activities conducted using a mobile game-based learning approach that was intended to develop students' problem-solving and collaborative skills. They showed that this approach can improve student learning significantly. Hwang, Wu, and Chen (2012) further reported that promoting interactions among students during the gaming process is helpful to students in improving their learning performance.

In conclusion, it can be concluded that collaborative learning has been recognized by researchers as one of the potential approaches for developing educational computer games.

3. Methodology

3.1 Research Design

In this study, we used Math Frogger, an enjoyable learning game that is fun for young students, to conduct collaborative, multi-touch game-based learning. Figure 1 shows an example of the game. We used this game to help students in a mathematics course to practice their addition, subtraction, multiplication, and division skills. As suggested by Kiili (2005), this game provides a frame story: by performing basic math calculations, the heroic frog character is able to cross the lily math pond to his frog princess (see Figure. 2). Math Frogger keeps students entertained with its simple and enjoyable features as well as the element of the fairytale environment provided by the frame story. This game provides a stimulating learning environment to encourage students to facilitate positive and initiative interaction, and construct their knowledge through game play. The game has a large variety of numeric challenges, with colorful animations. A competitive mode allows students to play the game together.

Figure 1. Example of a Math Frogger

The Math Frogger challenges students, engaging them in an enjoyable basic math learning process. The user interface is fairly easy to use, and provides clear-cut instructions at every step to help students to master the game quickly and achieve game flow. This game improves student's math skills in an experiential gaming process. During the gaming process, if students need assistance when they are confused, learning support is available to help students to solve problems, by providing scaffolds, which facilitate the zone of proximal development (Vygotsky, 1934/1978). In addition, students must race each other (or the computer) to be the first to reach the frog princess. The race itself is the most exciting part of the app, because math problems generally offer little variety. Players are presented with two choices, that is, two lily pads, each with a different number. The number on the lily pad represents the answer to a sum. Students choose the lily pad they want the frog to hop to, and a calculator appears with which they can solve the sum.

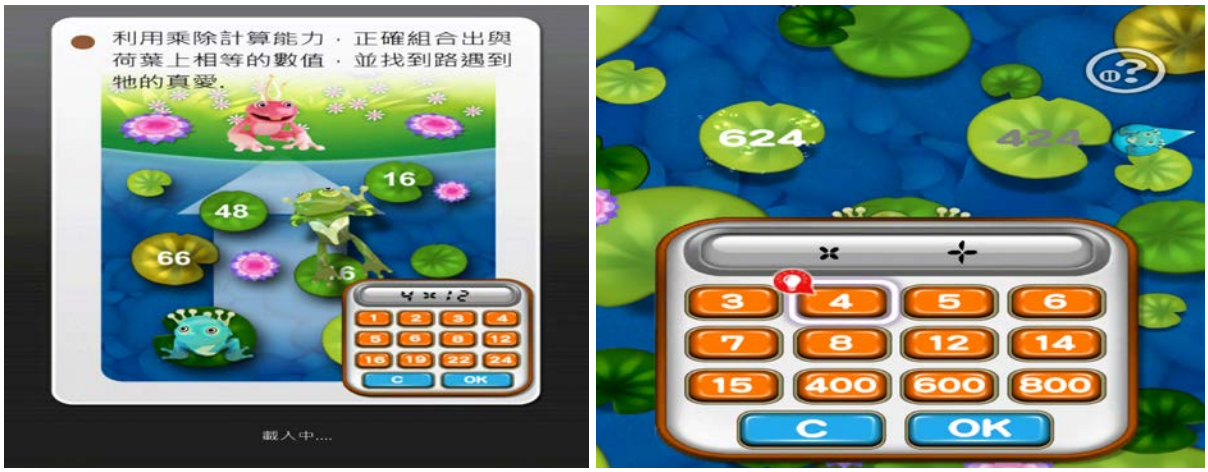

Figure 2. Task of a math frogger

3.2 Game Scenarios

Three game scenarios were proposed in this study to engage students and better immerse them in their learning environment. The first scenario pitted students against the computer, and the party that achieved the highest level in the mathematics game would find the princess, signifying completion of the task. In the second scenario, a competition among the students, the person who completed the task fastest and most accurately would find the princess. Finally, the third scenario adopted a collaborative approach where two students would form a team to compete against the computer, allowing members of each team to discuss and calculate answers together while completing the task. The fastest team to finish all the tasks would be designated the winner. The purpose of introducing three scenarios was to bring to the students a different flow experience, motivation, satisfaction, and learning performance under each scenario. These scenarios were used to investigate the effects of flow experience,

motivation, satisfaction, and learning performance on students and to observe whether the aforementioned four variables under the various scenarios would lead to different learning outcomes.

4. Conclusion and Future Research

In this study, the purpose of having three learning scenarios was to give students different challenges so as to produce different learning outcomes. In previous studies (Admiraal et al. 2011; Sung and Hwang 2013), collaborative game-based learning was used in the teaching and learning of other subjects (such as history and ecology), but not mathematics. Therefore, we made use of a multi-touch interface and combined it with collaborative game-based learning scenarios in the teaching of mathematics to determine whether this would produce the same learning outcomes as in the previous studies. However, this study is still at an exploratory stage of research, and thus the results have not been fully verified. In future studies, we will use both qualitative and quantitative approaches to verify that the collaborative game-based learning method can produce desirable learning outcomes in students.

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