A Path of Deploying Game-Based Learning into Classroom: An Empirical Study on Multiple Mice Supported One-Digit Addition Exercises Minigame

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Abstract

Game-based learning has emerged, and it is hopeful in having a radically transformative effect on schooling. However, in many ways, the resulting scope of the schooling transformation is not so much as that we had hoped for. Videogames have demonstrated the potential in engaging the kids, but, in general, schools are not ready for applying videogames. Using videogames in school is not only a technical problem, but also a set of problems covering content designs, students' learning achievement evaluations, parents' opinions, and the social culture values. In addition, deploying game-based learning into classroom is not like applying traditional software in school. In this study, we will discuss the potential obstacles of applying game-based learning in the classroom, and describe several concerns on applying game-based learning in school from teachers, students, and social culture perspectives. An empirical study applying multiple mice technology in face-to-face one-digit addition exercise minigame is reported.

Introduction

Game-based learning has emerged, and it is hopeful that it can cause radically transformative effects on schooling. However, in many ways, the resulting scope of the schooling transformations are not so much as we had hoped for. Videogames have demonstrated the potential in engaging the kids as well as in learning purposes, but classrooms are not ready for adopting videogames. Adopting videogames in classroom is not only a technical problem, but also a cluster of problems including pedagogical designs (Cheng, Wu, Liao & Chan, 2009), content designs (Chang et al., 2009), teachers' roles, learning assessments, parents' opinions, and the social expectations. The students of this generation are digital natives and they have very high interests in using videogames in classroom; so adopting learning games in the classroom for them is not a problem at all. However, the classroom is not only a place where learning takes place; therefore, the game-based learning designers should also be concerned about the teachers, the parents and the society expectations.

In this study, several obstacles and concerns on applying game-based learning in the classroom are described from teacher, student, parent and social expectation perspectives. Besides, an empirical study of applying multiple mice supported one-digit addition exercises minigame is elaborated. The goals of the minigame are to facilitate the kindergarten teachers to

enrich face-to-face interactions in the classroom, and to enhance the kids' one-digit addition number sense. Two game modes are designed. One is one-digit addition practice and the other is one-digit addition practice with game competition activity. The multiple mice technology is applied in the system, which means a computer can connect with more than one mouse. In this study, four mice were connected to a computer, and four kids could use the four mice simultaneously. Twelve kindergarten kids were involved in this study. The preliminary results indicate that the usability of the multiple mice supported one-digit addition minigame system was acceptable; the kids could use the system very well without any pre-training. The kids' attentions were improved a lot compared to the traditional arithmetic exercises. Some of the kids could answer more than thirty one-digit addition questions in seven minutes.

Concerns of Applying Game in Schooling

Games are a rich medium which provide a lot of benefits for learning. Many scholars advocate that the videogames are good for learning (Gee, 2003; Shaffer, 2007). As the information technology enhanced learning researchers, we all hope that the game-based learning, which is an effective and more engaged learning method, can be applied in the classroom. However, a school is a complex system which involves a lot of different groups of people, such as students, teachers, parents, principals, officers, and volunteers, and a place where there are a lot of social expectations. When talking about deploying game-based learning activities in schools, we not only focus on the students but other groups of people at school. No all of the groups of people can totally accept game-based learning approaches as the students do at school. Below, we will discuss the game design concerns, the teachers' options, and the culture issues in applying the game-based learning in the classroom.

Designing a Continuous Innovation Game in Classroom

Classroom is a place where equipped with a lot of affordances, such as desks, text books, resource materials and teaching aids. These affordances can be modified with the evolution of technology. The process of modifying these affordances needs a lot of complex and innovative designs which can much improve the classroom environment. The innovative evolutions can roughly be cataloged into continuous innovation (Boer & Gertsen, 2003) and discontinuous innovation. For example, electronic toothbrush is a kind of continuous innovation design comparing to the traditional toothbrush. A typical continuous innovation example in the classroom is the evolution of the blackboard. In the past, blackboards had occupied the classroom for several decades. Whiteboards, similar design to blackboard but with the character of being easy to erase and without chalk dust, have much improved the teachers' writing quality and take over the blackboard's role in the classroom. With the technology evolution, the single gun projector soon replaced the whiteboard in this decade. Recently, the electronic whiteboard makes the teaching and learning progress more active and more innovative to attract students and enhance the interactive chances. The evolution progress from blackboard to electronic whiteboard is a typical example of continuous innovation inventions affecting classroom settings. For teachers, a continuous innovation invention is much easier for them to adopt in the classroom rather than a discontinuous innovation invention. An extremely innovative tool for the teachers, and much different from the traditional classroom settings are the merits of the game, though it might cause the teachers to have much extra burdens. It will be much easier for the teachers to adopt a continuous innovation design approach as the game-based learning in the classroom.

Involving the Low Information Ability but Innovative Teachers in Game Design

School is a complex system that includes officers, principals, teachers, parents, students, and volunteers. Among them, teachers play a very important role if adopting game-based learning in classroom. They can decide whether the game can be applied in the classroom or not. In the case of applying information technology in the classroom like game-based learning software, the school teachers can roughly be divided into three categories. They are: 1) innovators, 2) followers, and 3) conservators (Chang, Chou, Chen & Chan, 2004). Innovative teachers willingly adopt new teaching strategies, software and technologies. These innovative teachers themselves can be further divided into two sub-groups of which one is the teachers with high information technology ability and the other one is the teachers with low information technology ability. High information technology innovative teachers generally can independently use information technology in learning effectively, but unfortunately only few percentage of teachers are innovators with high information technology ability. In general, most teachers are "followers." Followers imitate innovators once they see them applying game-based learning software effectively, and are particularly encouraged by the success of innovators with low information technology ability. Ideally, an event called the "migratory effectiveness of game-based learning" will occur once the percentage of followers applying game-based learning exceeds a certain threshold. Every school also contains a group of conservators. These teachers have become accustomed to their current existing teaching styles and are unable to easily adopt new teaching approaches. Based on the simplified scenario described above, the authors believe that the key to achieve the migratory effectiveness of game-based learning is to collaborate with the teachers who are innovators but with low information technology abilities.

Culture Issue

The term of game-based learning in Taiwan has been modified to a special name called joyful learning. The reason of using the term joyful learning instead of game-based learning is the culture issue in Taiwan as well as in the Asia-Pacific region. In the Asia-Pacific region with the Confucianism culture, the people used to have the belief that recognizing one's success is by his or her hard work rather than recreation. With this kind of belief, in general, the parents and adult citizens can't totally accept the pedagogies applying videogames in classroom. From this perspective, applying videogame in the classroom is not only a technological issue but a culture issue. When designing game-based learning software, the designers should be concerned with not only the functions of the software and the attractions for the students, but also the impressions from the society of the game.

An Empirical Study: Multiple Mice Supported One-Digit Addition Minigame

Human-computer interaction researchers have been trying and much supporting for the development of multiple mice design of which a computer can be equipped with many mice, and the users can use the mice on the computer simultaneously (Infante, Weitz, Reyes, Nussbaum, Gomez & Radovic, 2011). In this study, by using the multiple mice technology, a multiple mice supported competitive learning environment named K-MUSCLE was designed which represents the kids' version of the multiple mice supported classroom learning environment. K-MUSCLE is a system which has many previous versions covering on different domains (Chang, Yang, Yu & Chan, 2003; Lin & Chang, 2008; Chang & Chen, 2010). The K-MUSCLE is a version focusing on the design for the kindergarten students. Figure 1 displays the scenario of K-MUSCLE. In the scenario, the group of kids is equipped with a notebook which can connect with more than ten wireless mice. All the students of the group can share the notebook by using the K-MUSCLE system. Each one of the group is equipped with one wireless mouse in hand, and he/she can interact with each other in front of the computer simultaneously.

***Figure 1*. Concept of Multiple Mice Supported Arithmetic Minigame.**

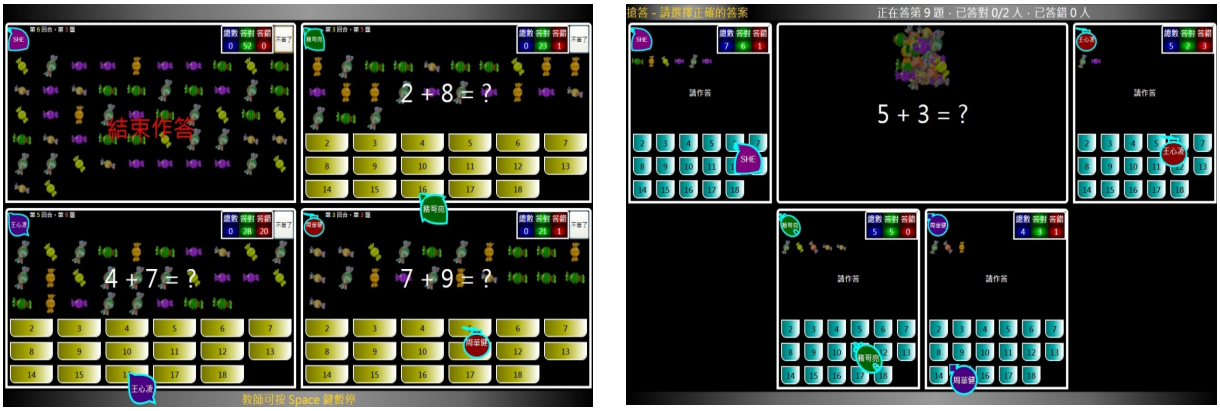
Functions Description

Solely providing a multiple mice environment for teachers and students is insufficient for practicing the K-MUSCLE. To facilitate the students in performing the K-MUSCLE, in this study, minigames designed for kindergarten kids are illustrated.

In the K-MUSCLE environment, all the mice cursors can be displayed on a shared notebook, and each student can move the mouse to identify the cursor. Once the student recognized the cursor, the student can click on his or her name to match the cursor. After completing the name assignment, the teacher can enter the next stage to assign the groups. The teacher can have all students in one group or divide the students into several different groups depending on the need of the modes.

The purpose of the K-MUSCLE system is to facilitate the kids to have a much better number sense in doing one-digit addition exercises. Via a lot of one-digit addition exercises, the kids can manipulate the one-digit number addition easily. As shown in Figure 2, there are two modes of the minigame of which one is an individual one-digit addition practice, and the other one is a one-digit addition practice with game competition. In the individual one-digit addition practice mode, the shared screen is divided into several zones equivalent to the participants. The kids can do the one-digit addition exercise individually with their own cursors in their personal

zone at their own speeds. The whole exercise ends only when all the students finish their tasks. A virtual candy is awarded to the kid who has the right answer. In the one-digit addition practice with game competition mode, all the kindergarten kids have the same one-digit addition exercise in the central area, but answer by their own mouse in their personal area. The mode is set as the three-chance mode. Only the fastest three students can win the virtual candies in each round. From game design perspective, the one-digit addition practice with game competition mode has higher competition intensity than the individual one-digit addition practice mode because the kids have to compete with others to give the right answers.



(a) Individual One-Digit Addition Practice (b) One-Digit Addition Practice with Game Competition

Figure 2. **Screenshots of the Multiple Mice Supported One-Digit Addition Practice Minigames.**

Discussion and Conclusions

How to apply the videogame in the classroom is a new trend for technology enhanced learning, and game-based learning researchers have demonstrated the potential of applying videogames in the classroom. However, considering the game-based learning deployment, there are still a lot of obstacles to overcome. In this study, we explore some videogame approaches that contain the strategies of continuous innovation and for the main purpose of having the teachers with innovation but with low information technology ability get involved and participate in. Besides, we should also pay more attention to the culture issues concerned with the game-based learning.

K-MUSCLE, the system introduced above, is still a prototype of the game-based learning. As the matter of fact, the multiple mice design is a kind of continuous innovation one for most teachers and students. The teachers who are willing to use the system can be the moderator in the classroom to interact with the kids. Although K-MUSCLE is still a prototype, a preliminary study has been applied in a kindergarten in Taiwan as a preliminary study. This is an informal preliminary study with twelve six-year-old kindergarten kids involved, and its purpose is to explore the usability and the adaptivity of the system. The result indicates that all the kids could control the mice smoothly and some of the kids could even answer more than thirty one-digit addition questions in seven minutes.

According to the previous experiences of deploying the minigame into the classroom, this study suggests that: 1) The teachers' roles in a game-based learning environment are critical. The game designers should consider how teachers could be involved in the minigame activities. 2) To

ensure every student participating in the game activity is very important, therefore, by using the multiple mice technology, every student can have the chance to use a mouse to interact with the peers. 3) The minigame design is a good approach because it can be integrated into the classroom activities as a supplementary material. Innovative game-based learning diffusion itself is an innovative process. In this study, we just mention some concerns of applying game-based learning in classroom. More approaches and opportunities might be ignored in this discussion, and further explorations are needed.

K-MUSCLE system demonstrates the potential of using multiple mice technology in the classroom, and the design of K-MUSCLE system also indicates that the system can provide affordable information technology accessibility in the classroom. By using the multiple mice technology, all the students can have the basic information technology accessibility and the cost is acceptable by the teachers. It also indicates the possibility of using non-PC-like human-interaction technology, such as gesture, wireless sensor and multiple-touch technology in the classroom. Obviously, the K-MUSCLE is still in its prototyping stage, both system implementations and well-designed evaluations are needed for the further pedagogical designs.

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