Exploring the Factors Influencing Different Cognitive Style Elementary Higher Graders’ Flow Experience in Blended Game-Based Learning Environment

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Abstract

The purpose of this study was to explore the factors influencing different cognitive style elementary higher graders’ flow experience in blended game-based learning environment. The research subjects were 150 sixth-grade pupils in Taiwan, which were divided into field dependence and field-independence by cognitive style. The blended game-based learning was used for all students. The experiment was implemented in 5 weeks. Collected data are going to be analyzed by descriptive statistics, t-test, one-way ANOVA. Finally, based on the results and analysis of this study, we are going to make recommendations to education practitioners and the future researchers.

Key Words: Blended learning, Game based learning, Cognitive style, Flow experience
1. Introduction

Rapid developments have been made in information technology, which has revolutionized almost every aspect of our lives, whether it may be learning, games, or daily activities. Many convenient learning models have been created under the lead of information technology. Embedded in the internet, e-learning was a breakthrough in the limitations of time and space in recent years, and led to another wave of developments in traditional electronic games. More and more games are now web-based, and users can challenge the computer at any time and any place with an internet connection, bringing them new experiences and entertainment. Factors of game design have the potential to increase children’s participation intention, and can thus improve their understanding of the contents and concepts (Gee, 2007; Squire, 2011). Compared with traditional learning methods, game-based learning is more suitable and allows students to be more involved in learning (Prensky, 2001). Game-based learning also influences motivation and is related to students’ intention to participate in assignments and activities. Malone and Lepper (1987) pointed out that seven factors can improve motivation: challenge, curiosity, control, fantasy, competition, etc., most of which are provided by games. Studies have found that electronic games increased children’s interest more than traditional classrooms (Manero, Torrente & Serrano 2015). Other studies pointed out that educational games increase students’ learning interest (Ebner & Holzinger, 2007) and further increase their learning motivation (Dickey, 2011; Hwang, Sung, Hung & Huang, 2012). Many researchers pointed out that educational games have the potential to help students’ learning performance (Brom, Preuss & Klement, 2011). Educational games are an effective approach to gaining knowledge by providing an interesting learning environment. Some scholars claim that a well-designed computer game can provide a learning environment with abundant resources for learning challenges, and elevate the level of students’ knowledge and skills. Wang & Chen (2010) further pointed out that “students” can achieve better learning performance in a game-based learning environment that integrates suitable learning contents and strategies, while maintaining the fun of games.” In the past, many researches involving digital games mainly focus on players’ game behaviors and fun. Particularly, the players’ flow is often used to discuss these behaviors.

In summary, flow experience is an important factor to whether or not learning is effective. Developments in network technology in recent years have led to a gradual increase in studies on game-based learning support systems, but there are relatively few studies on blended game-based learning support systems designed based on cognitive styles for mathematics. Therefore, this study aims to explore the factors influencing flow experience in blended game-based learning and develop a game-based learning support system that applies cognitive studies, and
examines the differences among field dependent and field independent students that use this system for learning speed unit.

2. Literature Review

Differences in gender, prior knowledge, cognitive style, and learning preferences of students may result in different learning performance (Cassidy, 2012; Chen & Sun, 2012). Hence, many studies have investigated the influence of individual differences on learning performance, in hopes of designing a suitable learning support system for students; these learning systems are generally referred to as personalized or adaptive learning systems (Dolenc & Aberšek, 2015; Yang, Hwang & Yang, 2013; Klašnja-Milićević, Vesin, Ivanović & Budimac, 2011). Students’ learning is closely related to their cognitive style, which represents characteristics of their cognition and thinking patterns in the decision making process (Messick, 1976; Morgan, 1997). Cognitive styles are divided into many different categories, in which field dependent (FD)/field independent (FI) styles are determined based on the cognition of images by individuals (Witkin & Goodenough, 1977). FI learners are good at analysis, competitive, individualistic, task-oriented, visual perception, intrinsic motivation oriented, self-construction, and linear; FD learners are group oriented, sensitive to social interactions, and extrinsic motivation oriented (Garger, 1984; Saracho, 1989). FI and FD learners respond differently to learning contents, in which FI students will be inclined to show more individual actions, because they do not need additional instruction to process information, and they are able to develop personalized intrinsic instructions and construct knowledge. In contrast, FD students are more likely to be influenced by external factors (Witkin, Moore, Goodenough & Cox, 1977). FI students analyze the environment they come in contact with, like to learn independently, are able to set their own goals and achieve self-reinforcement. FD students come in contact with the environment from an overall perspective, like to learn cooperatively in groups, and need external objectives and reinforcement (Evangelos, Andreas, & Demetriadis, 2003). Cognitive style simply represents the use of different strategies and does not imply that any style is superior over the other (Jonassen & Grabowski, 1993).

Some scholars conducted studies that combine cognitive style and game-based learning in recent years. Chang, Chen & Jhan (2015) examined students with different cognitive styles using an interactive digital game and found the FI students had better learning outcomes, while FD students had higher tolerance for frustration. Hong, Hwang, Tam, Lai & Liu (2012) found that in a game-based learning environment FI students were more able to focus on the game and learning activity than FD students. Kaewprapan & Suksakulchai (2008) found that FD students were more motivated than FI students when learning in a virtual environment. Soflano, Connolly & Hainey (2015) pointed out game-based learning achieves better learning outcomes.
than textbooks, and a game-based dynamic learning system that responds to students achieve better results than non-adaptive learning systems.

3. Methodology

3.1 Research Questions

This study aimed to investigate the factors influencing different cognitive style students’ flow experience in blended game-based learning environment. The objects of this study included four classes from sixth grade students in an elementary school. They were divided into field dependence group and field-independence group by “Hidden Figures Test”. After receiving the pretest, 2 groups received a five-week, three lessons each week (40 minutes each lesson) Blended Game-Based Learning Instruction in mathematics studies. After that, they were given a posttest.

In this study, the quantitative statistics will be analyzed. For quantitative statistics, the study adopt ‘The questionnaires of the game flow state’ ‘The questionnaires of learning motivation’ and ‘Speed Unit Learning Achievement Assessment’ as tools for research. Then with scores obtained in the pretest as covariation, and the quantitative data are analyzed by the one-way ANCOVA. The variables framework in the research is as follows,

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Control Variable</th>
<th>Dependent Variable</th>
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<tbody>
<tr>
<td>Cognitive style</td>
<td>teaching method,</td>
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<td></td>
<td>learning materials,</td>
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<td>Flow experience,</td>
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<td>Learning motivation,</td>
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<td>learning Efficiency</td>
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</table>

3.2 Game Design

The digital game design in this research is based on sixth grade mathematic unit ‘speed’, experimental subjects have to enter the game according to the learning progress.
The login page of the digital game is divided into four levels, “the meaning of speed, ratio, fast vs slow and conversion rate.”

After entering the game, players will see the question about the topic and have to think about how to solve it.
According to the situation and the clue, players should enter the right answer and then move on to the next level.

Figure 4: System Feedback Page
3.3 Research Instrument

3.3.1 Flow Experience

The questionnaires of the game flow state in the research is modified from Pearce et al (2005). Experimental subjects do the questionnaires after finishing the digital game challenge immediately. The questionnaire consists of the following:

You have now completed an activity.
Before you continue please answer the following question.

(a) How challenging did you find this last activity?

<table>
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(b) Were your skills appropriate for understanding this last activity?

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3.3.2 Hidden Figure Test

The hidden figure test was created by Messick in 1962 to test the ability of subjects to find basic figures among complex figures. The test determines if the cognitive style of subjects is FI or FD. There are 32 items all with five choices and one answer. Each item is a complex figure and the subject must find one of five known basic figures from the complex figure. Subjects that are more easily affected by the complex lines in the background are FD learners, and subjects that are less prone to being affected by the complex lines in the background are FI learners. The test time is 20 minutes, and subjects that score higher within the time are inclined towards FI learners.

3.3.3 Math Knowledge Learning Outcome Test

A pre-test and post-test are administered to understand the learning outcome and differences between FD and FI students for learning ‘speed’ unit. The test overall had good internal consistency with Cronbach’s α at 0.711; expert validity was adopted by teachers of math at an elementary school in Taiwan.

4. Data Analysis

Research subjects are 120 sixth graders in an elementary school in Hsinchu City, Taiwan. Students are divided into two cognitive styles, namely FI and FD, using a hidden figure test. Contents of the teaching materials are mathematics “speedy” knowledge presented by the digital game for learners of different cognitive styles, examining the learning outcome, learning
motivations and flow experience of students with different cognitive styles after using playing the game. The system has five levels, specifically “The Meaning of Speed,” “Ratio,” “Fast vs Slow,” and “Conversion Rate.”

All students took a pre-test of their speed knowledge and learning motivation before taking the course; After finishing the blended game based learning, all students took post-test of their speed knowledge, learning motivation and their flow experience.

An independent samples t-test is used to determine the difference in learning outcome of the two groups of students after learning speed knowledge in blended game based learning. Furthermore, when examining the difference in learning outcome of the two groups of students, “group” and “cognitive style” are used for two-way ANOVA to determine if interaction between the improvements of students with different cognitive styles was significant after game based learning. The flow experience status survey was analyzed to determine the factors influencing different groups of students after blended game based learning.

5. Expected Results

Games play an important role in psychological, social, and intellectual development, especially during childhood (Rieber, 1996). Compared with traditional teaching methods, educational computer games provide a more interesting learning environment for students to gain knowledge (Cagiltay, 2007). We expect that the blended game-based learning can enhance students’ overall learning effectiveness in mathematics. It facilitates students with flow experiences of math to achieve better flow experiences.

Students have better learning outcomes when they learn in a style that fits their cognitive style (Huang, Hwang, & Chen, 2014; Hwang, Sung, Hung & Huang, 2013). If feedback from the learning system matches the cognitive style of learners, then integration of learners and the learning system will be more effective (Brezillon & Pomerol, 1997). We expected that the research results will show an improvement in learning outcomes and learning motivations of students in both FI and FD after blended game-based learning. Besides, it shows better outcomes on flow experience in FI group. Therefore, this shows that FI students are suitable for this digital game in mathematics, and blended game-based learning has a positive effect on children learning speed concepts.

References

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