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Cognitive Style Affected Students' Frustration Tolerance and Achievement on Group Face-to-Face Competitive Game

Ben CHANG[a*], Sin-Ni JHAN[b], Jhan, Yu-Xuan WEI[b]
[a]*Center for Teacher Education, National Central University, Taiwan*
[b]*Department of E-Learning Design and Management, National Chiayi University, Taiwan*
*bchang.tw@gmail.com

Abstract: In classroom, group competitive game is widely believed to be a motivation-enriching strategy, and has been suggested as a way to stimulate participants' engagement. However, different students perceive the same competitive activity with different feelings. The more we understand students' characteristics, the more adaptive support we can provide students. This study aimed to explore the different cognitive styles causing to the influences on the frustration tolerance and achievement through a tablet group competitive board game. In the aspect of cognitive style, the differences between field dependence and field independence were explored, and in the aspect of group competitive game, a face-to-face group competitive board game named "Multiple-Choice Practice Island" as the classroom setting was implemented on tablet as an APP. A pilot study was conducted in which twenty-three 3rd grade students were involved. The results demonstrated that group competitive game can increase the students' frustration tolerance whether they are field dependent or field independent cognitive style students, and the low-achieving field independent students perceive more learning achievement in the group competitive game.

Keywords: Face-to-face competitive game, cognitive style, frustration tolerance, APP

1. Introduction

Social activity design and how it affects learning have been considered as important issues in educational research (Vygotsky, 1978). With the development of technological learning tools, more and more technological learning resources can support face-to-face group learning (Chang, Chuang, & Ho, 2013). Accordingly, the exploration of the group learning interaction has become a crucial issue. Among the various social learning activities, competition, an instinctive human behavior, plays a role in the design of a technologically supported learning environment. Obviously, excessively competitive learning activities can have many negative effects. High-achieving students and low-achieving students perceive the same competitive activity with different feelings (Cheng, Wu, Liao & Chan, 2009). People who walk away from a victory will experience a different emotional state than the ones who walk away from a loss (Kohn, 1992). However, competition is generally considered an effective technique in motivating people to learn and to excel (Yu, Chang, Liu & Chan, 2002; Chang, Yang, Yu & Chan, 2003). Adding an element of competition is widely believed to be a motivation-enriching strategy in play, work, and education (Deci, Betley, Kahle, Abrams & Porac, 1981; Chang, Wang, Peng & Hsu, 2010). Additionally, competition has been suggested as a way to stimulate users' direct involvement and interest. The use of competition strategies in a classroom is a method that incurs both positive and negative effects. Studies on the challenge of applying competitive strategy in a learning environment therefore should focus on understanding how competition affects the students' attitudes, such as frustration tolerance, and how to take advantage of students' increased motivation and positive learning effects, and decrease the negative effects of competition.

Classrooms are the environment where students spend most of their daily time and where they encounter learning activities designed to cover cooperation, competition and individual learning. Johnson and Johnson (1998) mentioned that competitions need to be kept light and fun, preferably in

the format of a game. Additionally, students should be grouped homogeneously. Beyond the explorations of classroom learning activities, researchers are interested in understanding students' emotional development (Schutz & Pekrun, 2007). Because each learner has her/his own characteristic, different individual human factor will influence the group learning activity under the learning circumstance of the same learning task. The more we understand students' characteristics, the more adaptive support we can provide teachers and students. Integrating social activities into classroom environment is an important issue when designing technology-enhanced classroom learning systems. Digital learning devices in classrooms provide teachers and students with a new interaction media. In the classroom, technology is a facilitator that helps aid quality interaction between teachers and students under a well-designed content and pedagogy.

In this study, a tablet APP supported competitive learning activity named "Multiple-Choice Question Practice Island" was designed and implemented for the teachers and students to have face-to-face group competitive game in the classroom. Through this system, the students can interact with their peers face-to-face on the tablet simultaneously to complete computer-assigned multiple choice questions tasks. Through the tablet APP group competitive board game, the objective of this study is to investigate different cognitive styles causing to the influences on the frustration tolerance and the students' achievement.

2. Multiple-Choice Question Practice Island System

2.1 System Introduction and Outline

Practice is regarded as an important element for effective instructional outcomes (Gagne, Briggs, & Wager, 1992; Dick et al. 2001). Gagne (1985) has concluded that there are several necessary conditions for effective learning of each type of objective, and one condition that pertains to all domains of instructional objectives is practice of the desired skills. Besides, a student with fluent skill can reduce her/his cognitive load, and can indirectly enhance her/his learning outcomes. Hence, the "Multiple-Choice Question Practice Island" game geared towards developing a face-to-face domain-independent system, which can engage students in the practice activity to promote better learning, and to engage students in drill-and-practice exercises was launched.

The main interface of the "Multiple-Choice Question Practice Island" comprises four parts: Item Showing Area, Answering Area, Game Map, and Agents as illustrated in Figure 1.

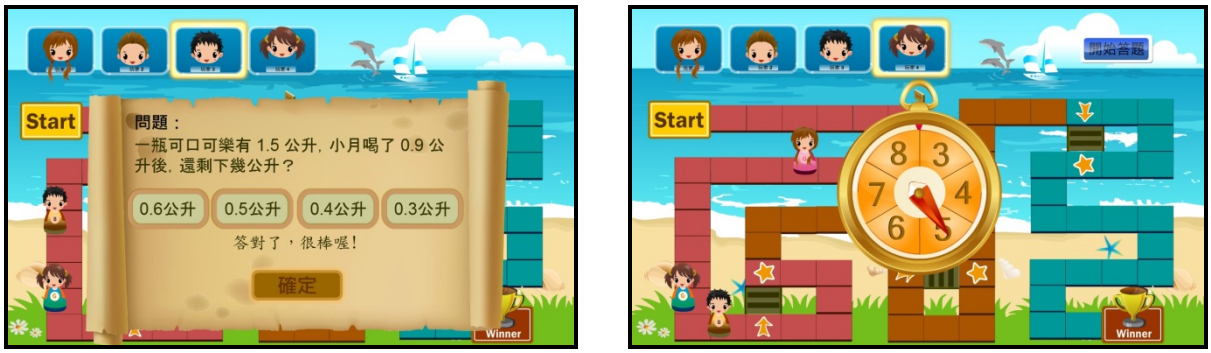

Figure 1. The Screenshots of Multiple-Choice Question Practice Island Game.

- Item showing area: Multiple-choice questions, a domain independent item bank format, are posted to users via the item showing area.
- Answering area: Four options are displayed in the answering area, and players answer the multiple-choice questions via the answering area.
- Game map: Users and their competitors participate in a competitive activity on the game map.
- Agents: One to four agents selected by the users are displayed on the game map.

At the start of the game, the icons represented the players are placed at the begging of the game map. All the players then answer the multiple-choice questions posted by the tablet in turn. The player is given a random number ranking from 3 to 8 upon choosing the correct answer, and the player's icon is moved according to the number the play got. Several shortcuts are designed on the game map. A user jumps forward to the next stop upon reaching the shortcut position. A user must places her/his icon on the "Winner" position to win the game. The practice of the system is shown as Figure 2.

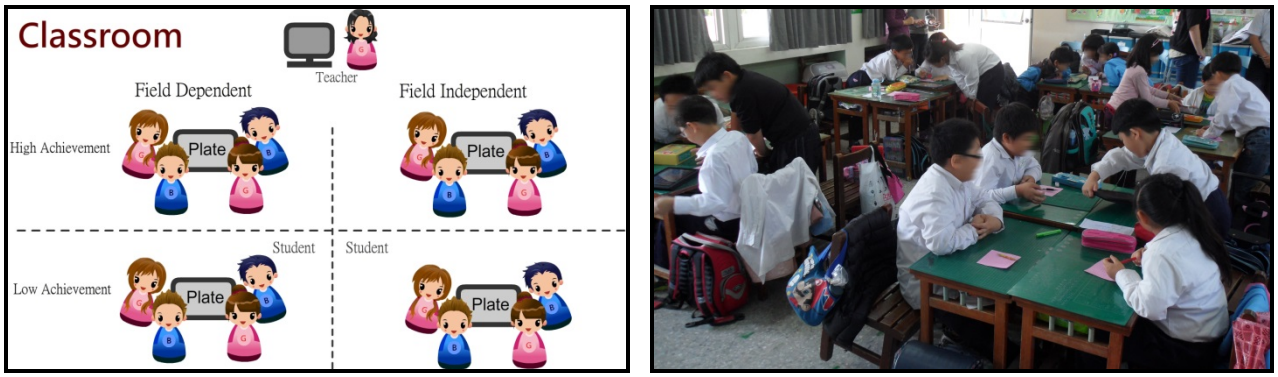

Figure 2. The Practice Scenario and Its Real Implementation.

3. Methods

To assess the different cognitive styles causing to the influences on the frustration tolerance and effective learning outcome through the Multiple-Choice Question Practice Island game, several research tools, including the Group Embedded Figures Test (GEFT) worksheet (Witkin, Oltman, Raskin, & Karp, 1971), mathematical frustration tolerance questionnaire (Clifford, 1988) and mathematics achievement test worksheet, were applied. Among the research tools, the GEFT reliability was .82, and the mathematical frustration tolerance questionnaire reliability was .86. A quantitative approach was applied. The independent variable was cognitive style divided into field dependence (FD) and field independence (FI) based on the GEFT test result. Besides, the students were further cataloged into high-achieving and low-achieving students measured in accordance with the mathematics achievement pre-test result. Dependent variables were frustration tolerance and achievement. According to the GEFT test result, ten of the students were distinguished as field independence, and thirteen were field dependence. Three to four students as a group was assigned to play the face-to-face Multiple-Choice Question Practice Island game.

The subject of this experiment is third grade ten thousand addition and subtraction topic. Before the experiment, the students were measured with mathematics achievement test worksheet and frustration tolerance questionnaire survey. When played the Multiple-Choice Question Practice Island game, three to four students shared a tablet. The multiple-choice question item was displayed on the tablet randomly. All the students played the Multiple-Choice Question Practice Island game four times in two weeks. Each time lasted for one hour. All the results of the game were recorded including the players' scores, the players' answers, the ranking, and the players' movements. The pre-test and post-test were applied before and after the four-time gaming section separately.

3.1 Frustration Tolerance Results

The frustration tolerance questionnaire was applied before and after the experiment. ANCOVA results showed that different cognitive styles and achievement of students in frustration tolerance caused no interaction ($F=1.44$, $p>.05$), which means that the group competitive board game did not result in differences in the different cognitive styles and

learning achievement. Mathematical frustration tolerance dependent sample t-test results showed that all students have significantly improved in the Multiple-Choice Question Practice Island game. Mathematical frustration tolerance measured significantly higher than the pre-test (t=-2.4, p<.05), which means that all students' mathematical frustration tolerance significantly improved after playing the game.

Table 1: Dependent sample t-test on Math Frustration Tolerance

Variable	M	N	S.D.	t	Sig.
Frustration tolerance pre-test	76.48	23	12.30	-2.40	.026*
Frustration tolerance post-test	80.04	23	12.12		

** p<.05*

3.2 Achievement Results

Regard to the mathematics achievement, the ANCOVA analysis was adopted to compare the different cognitive styles and the test scores of pre- and post-mathematics achievement. Table 2 lists the summary of the results.

According to the results, differences between students in different cognitive styles and achievement under the influence of the pre- and post-test results for the analysis of covariance, cognitive styles and learning achievement have significant interaction (F=4.62, p<.05), and with different cognitive styles have significant differences (F=9.61, p < .05) (see Table 2). For further interaction test of simple main effects found the low-achieving students with different cognitive styles were significantly different (F=6.97, p<.05). Furthermore, the low-achieving field independence (M=97.33) students were significantly higher than the low-achieving field dependence students (M=77.58). However, the phenomenon was not found on high-achieving students.

Table 2: ANCOVA summary of different cognitive styles and achievement

Variable	SS	df	M.S.	*F*	Sig.
Cognitive styles（A）	654.31	1	654.31	9.61	.006**
Achievements（B）	124.85	1	124.85	1.83	.192
Cognitive styles* Achievements（AxB）	314.60	1	314.60	4.62	.045*

***p<.01, *p<.05*

Table 3: Simple main effects summary of different cognitive styles and achievement

Variable	SS	df	M.S.	*F*	Sig.	Post-hoc tests
A variable（Cognitive styles）						
b1（High-achieving）	35.66	1	35.66	.94	.356	
b2（Low-achieving）	795.06	1	795.06	6.97	.033*	FI＞FD
B variable（Achievements）						
a1（Field Independence; FI）	1.56	1	1.56	0.64	.807	
a2（Field Dependence; FD）	242.29	1	242.29	2.30	.160	

**p<.05*

4. Discussions and Conclusions

In classroom, group competition is widely believed as a motivation-enriching strategy, and practice is regarded as an important element for effective learning. To test the group competitive practice game idea, in this study, a Multiple-Choice Question Practice Island game was designed and implemented, in which up to four students can face-to-face play a drill-and-practice game on a tablet simultaneously. To assess the different cognitive styles causing to the influences on the frustration tolerance and achievement through the Multiple-Choice Question Practice Island game, a pilot study was applied. Twenty-three third grade students were involved, of whom ten were distinguished as field independence and thirteen were field dependence.

The pilot study indicated that:

1. Game might enhance the students' frustration tolerance

In the frustration tolerance study, there was no significant difference between students on different cognitive styles ($F=1.44$, $p>.05$), which indicated that the group competitive game did not affect students with different cognitive styles frustration tolerance. However, the frustration tolerance dependent sample t-test results indicated that the students' frustration tolerance had significantly improved ($F=30.68$, $p<.001$). It means that the students after using the group competitive board game could effectively improve frustration tolerance degrees.

2. Low-achieving field independence students perform better in the group competitive game

The study results indicated that there was an interaction exists ($F=4.62$, $p<.05$). The low-achieving cognitive style students had a significant difference ($F=6.97$, $p<.05$). According to the results, the low-achieving field independent students performed significantly better than the low-achieving field dependent students. That means that the group competitive game is conductive to the low-achieving field independent students, but no difference for high-achieving students. The reason might be that the low-achieving field independent students have less subject to interference from their peers. Conversely, the field dependent students are vulnerable to the impact of the external environment with more external factors and peer interactions. For high-achieving students, there is no significant different on achievement, and the reason might be the ceiling effect due to high achievement rate of progress was not significantly different.

These two findings, the group competitive game might enhance the students' frustration tolerance and the low-achieving field independent students have better achievement in the group competitive game, are interesting. However, this is a pilot study. The experimental design and the participant numbers still have room to improve, and the results need to verify more detailed.

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