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Inferred Learning Strategy in Two-User-One-Computer Environment Study from Cognitive Style Perspective

Jo-Yu HUANG[a*], Ben CHANG[a], Yi-Jie LIN[b] & Fang-Chen LU[a]
[a]*Graduate Institute of Learning and Instruction, National Central University, Taiwan*
[b]*Department of E-learning Design and Management, National Chiayi University, Taiwan*
*traci9034@gmail.com

Abstract: Prediction-observation-explanation (POE) inquiry approach has been proven as a useful approach in helping students to inquire and to understand the subject deeply. Computer has demonstrated its power on simulation which can simulate a lot of environment. Combining the POE model and the computer simulation power, the authors propose an extended model named PSOE which represents prediction-simulation-observation-explanation model. A simulation APP game, "Newton's Miracle," was implemented to test the PSOE model. To explore the APP game usability on different cognitive styles students, an experiment was conducted in which fifty-six 8th grade students were involved. The experimental results indicate that the students' learning achievement has improved, and the field independent and the low achievement students perceive more learning achievement from the APP game.

Keywords: Prediction, inquiry-based learning, game-based learning, cognitive styles

1. Introduction

In mobile devices supported classroom design, a straightforward thought is to equip each kid with one mobile device. However, classrooms are the place where students have their peers to interact with. We will argue that letting two students to share one computer can help to enhance their interaction, and to attract their discussion and understand on the learning subject. In this study, the authors adopt two-user-one-computer design approach which means two students use one computer face-to-face together to design a PSOE (prediction-simulation-observation-explanation) game. PSOE is extended from POE (prediction-observation-explanation) model (Hong, Hwang, Liu, Ho and Chen, 2014). In the PSOE environment, one of the paired students firstly proposes a question, the other student predicts the result consequently. Once both of them agree the proposed question and the proposed prediction result, the computer then simulate the results to test the proposed prediction result. The students then compare the differences among the prediction and the simulation results and give a reasonable explanation. To exam the PSOE concept mentioned above, the authors implemented a two-user-one-computer simulation APP game named "Newton's Miracle." Besides, to study the system more systemically, the field dependent (FD) and field independent (FI) cognitive styles were considered to investigate different cognitive styles students' responses on the "Newton's Miracle" game. An experiment which involved fifty-six students was conducted to test the APP game. The results indicated that the game was helpful for the students to improve their subject understanding especially for the FI students and low achievement students.

2. Method

2.1 "Newton's Miracle" System Introduction

In this study, the authors developed a two-user-one-computer simulation game named "Newton's Miracle" which is an inferred learning strategy tablet APP game. The game is a paired game which

means two students play the game together. In the game, one of students plays the environment arrangement role setting the simulation environment, and the other one plays the prediction role predicting the simulation results. The subject of the game is Newton's Laws of Motion. As shown in Figure 1, at beginning of the game, one of the paired students sets the values including the power of the force, and the force angle on the ball. The other student then needs to predict the movement of the ball. After both of the students complete the parameters settings and the result prediction, a physical simulation software engine is used to simulate the settings, and simulates physical simulation result. The game then calculates the score in this turn. The more accuracy rate the prediction, the higher scores the participant win. After complete a round, the paired students exchange their roles and start next round until one participant's score is higher than 100. Students can directly understand the Newton's Laws of Motion through computer simulation.

Figure 1. Newton's Miracle System Screenshots.

2.2 Participants and Research Instrument

Fifty-six 8th grade students from a junior high school students in Taiwan took part in this study. Among them 27 were males and 29 were females. Due to taking into account the fairness, the homogenous grouping strategy was adopted in this study. More specifically, two students with a similar level of prior achievement and same cognitive styles were formed as a group according to the results of the measurement of cognitive styles and pre-test. The participants all had the basic knowledge about Newton's Laws of Motion and didn't have any experience about computer simulation course. The experimental procedure is composed of five steps. They are preliminary training, cognitive style measurement, pre-test, interactions with "Newton's Miracle" system, and post-test.

The preliminary study took five days and forty minutes per day. On the first day, the participants were initially trained to know how to play the "Newton's Miracle" game, involved to do cognitive style measurement and the pre-test of the Newton's Laws of Motion. The cognitive style dimension investigated in this study was the level of field dependence. The group Embedded Figures Test (GEFT) is used in the study (Witkin, Oltman, Raskin and Karp, 1971). The GEFT reliability (α=.82) is properly and frequently utilized instrument to measure an individual's degree of field dependence (Hong, Hwang, Tam, Lai, & Liu, 2012). Two similar pre-test and post-test tests were designed by a junior high school science teacher who was familiar with Newton's Laws of Motion. The pre-test and post-test were common physical movement phenomenon of life based on Newton's Laws of Motion. The total score of the pre-test and post-test of the Newton's Laws of Motion was 100. Among the 56 participants, 16 were measured as FI and 22 as FD. We also classified students to high achievement group and low achievement group by the score of pre-test. Among the students, 18 were measured as high achievement and 20 as low achievement. To ensure the participants' correct use of the system, the researcher explained the operation of the system and demonstrated to them before they did the experiment. On the last day, after the experiment had finished, participant had post-test of Newton's Laws of Motion.

3. Preliminary Data Analysis

In this study, the independent variable was the cognitive styles (i.e. FI or FD). The dependent variables were the pre-test and post-test scores from the Newton's Laws of Motion tests. In addition to the pre-test

and post-test scores, another dependent variable was the gain score, which was obtained by finding the differences between the pre-test scores and post-test scores.

The paired t-tests were carried out to test whether significant differences exist between pre-test and post-test for the 56 participants. In learning achievement of Newton's Laws of Motion, the mean score of pre-test was 46.07 and the mean score of post-test was 55.54. The result of paired sample t-test suggested that the mean score of post-test was significantly high than the mean of pre-test ($t = -4.85$, $p < .05$).The results suggested that the participants' score had significant improvement after playing "Newton's Miracle" game. As shown in Table 1, there was a significant progress for the students. The preliminary findings indicated that the "Newton's Miracle" system was helpful for the students to learn Newton's Laws of Motion.

Table 1: Pair sample t-test of learning achievement.

Variable	M	N	S.D.	t	Sig.
Pre-test	46.07	56	15.57	-4.85*	.000
Post-test	55.54	56	17.93		

*p<0.5

To further analyze the data, the differences of learning achievement and cognitive styles of participants were involved. The statistics of the results were listed in Table 2. The data indicates that all the participants had improvement in the subject, especially the FI students whoever they were high achievement or low achievement students. Besides, the low achievement students, in general, have a lot of improvement on the learning subject. This is a preliminary study. The reasons causing those effects still need further study.

Table2: Descriptive statistics analysis of learning achievement.

	Learning achievement	N	Pre-test	Post-test	Improvement
FD group	Low achievement	12	32.08	44.58	7.50
FD group	High achievement	10	56.00	60.00	4.00
FI group	Low achievement	8	40.00	59.38	19.38
FI group	High achievement	8	60.63	72.50	11.87

4. Conclusions and Discussion

In this study, based on POE model, an extended PSOE model which including prediction, simulation, observation and explanation learning activities was proposed. To test the PSOE model, a simulation game named "Newton's Miracle" was implemented. The subject of the system was Newton's Laws of Motion. In the system, two students can play the simulation game together face-to-face simultaneously. According to experiment results, the participants completed PSOE interactive learning activity showed that their scores had increased significantly. Meanwhile, the FI students and low achievement students had higher improvement than high achievement students. This is just a preliminary study. The system and the evaluation process still have a lot of room to improve.

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