Chen, W. et al. (Eds.) (2017). Proceedings of the 25th International Conference on Computers in Education.
New Zealand: Asia-Pacific Society for Computers in Education

The Effects of SDE Strategy-based Computer Games on Metacognitive Awareness

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Abstract: Some studies show that game-based learning can raise learners' motivation to attract learners into learning activities, and students' metacognitive awareness is an important factor of learning performance. The SDE strategy is considered to be the form of self-dialogue learning, which can help learners to reflect and monitor the self-learning states. Therefore, in this study we proposed a SDE strategy-based computer game for learning the fraction course of the fifth grade. This study adapts a quasi-experimental design, where the students were randomly assigned to two groups. The results showed that the SDE strategy was helpful to the learners' control and reflection on the self-learning state, so that the learners could clarify the concept of fraction in the learning process, and thus achieve learning goals.

Keywords: digital based-game learning, self-explanation, metacognitive, fraction.

1. Introduction

In recent years, many researchers try to integrate information technology into education, among which the learning content and game material combined into the digital game-based learning (DGBL) towards this direction to exploration (Castellar & Looy, 2016; Wouters & Oostendorp, 2013; Hsu, 2012). The SDE strategy (Self-explanation, group-Discussion, re-Explanation) was proposed by Chang Tzyh-Lee from Team-based Learning. Through this way, the instructor can understand the relevant concepts of learners after the teaching process. And then lead students to group discussion. During the process, group members can discuss with each other or produce conflicting ideas, and their own opinions might be changed. At last, the learners once again to provide their own opinions. Thus, in this study, we proposed a SDE strategy-based computer game for learning mathematics. Moreover, an experiment has been conducted in an elementary school mathematics course to evaluate the effectiveness of the following research questions: Do students who learn with the SDE strategy-based computer game have better metacognitive awareness inclination than students without the SDE strategy?

2. Literature review

2.1 Digital Game-based Learning

Digital games are considered to be an influential learning tool because digital games can present learning resources in a diversified way and maintain a strong appeal. If the game mechanism is designed properly, it can provide an immersive and interactive environment, will be able to attract learners to thinking abstractly and help them understand the complex concept.

However, Adams & Clark's (2014) has found that gaming practice can lead players to try some actions until the score has been raised. Because of the lack of reflection on the results, learners can't identify their learning status, and hence usually make wrong behaviors without any enhancement in learning. For this reason, this study aims to propose a SDE strategy-based computer game to explore the effect of learners' metacognitive awareness inclination.

2.2 SDE Strategy (Self-explanation - group-Discussion - re-Explanation)

The SDE Strategy (Self-explanation - group-Discussion - re-Explanation) is proposed by the Chang Tzyh-Lee, and is a variation of the Team-based Learning strategy. Through applying the SDE strategy, learners will enhance the self-learning and teamwork ability. Learners not only learn to be responsible for their own and the team's learning, but also to know how to work with others, and most important of all, these two abilities are required at the current era.

The research application of SDE strategy in education is applied to natural science course of the elementary school. However, the SDE strategy has not been integrated into a digital computer game; therefore, this study aims to integrating the SDE strategy into a computer game in order to raise up learner's metacognitive awareness inclination.

3. Experimental Design

In order to evaluate the effectiveness of our proposed computer game, an experiment was conducted to compare the metacognitive awareness inclination of the students between two groups. Participants are 48 fifth grade students from a diverse public middle school at New Taipei City. The students were randomly assigned to two groups: 24 in the experimental group and 24 in the control group. The difference between two groups was that the experimental group used the SDE strategy-based computer game to help students learn math. Fig. 1 shows the computer game, called "Discover a Whale Island."

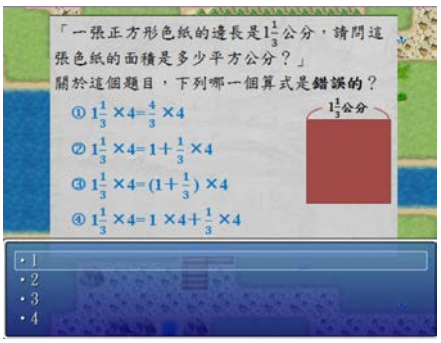

Figure 1. Screen shot of Discover a Whale Island.

Regarding the questionnaire, we conducted two rounds of questionnaire to probe the participants' metacognitive awareness inclination. The questionnaire topics are the same, adapted from Lai and Hwang (2014) metacognitive awareness inclination questionnaire, and there are totally 5 questions. The questionnaire uses a 5-point Likert scale, where 5 means "strongly positive" of metacognitive awareness inclination. The questionnaire has a good intrinsic reliability (Cronbach's alpha = 0.83).

4. Results and Discussions

4.1 Metacognitive Awareness Inclination

The results of the Paired Sample t test showed that the experimental group ($t = -3.218$, $p = .004 < .01$) had a significant difference in the metacognitive awareness inclination after the experimental learning activity. In addition, the analysis of homogeneity of within-class regression coefficient showed that the two groups had no difference with $F = .029$ ($p = .866 > .05$), implying that the homogeneity test was passed. Following that, Analysis of covariance (ANCOVA) was employed to analyze the post-questionnaire scores of the two groups by excluding the effect of the prior-questionnaire scores. Table 1 shows the ANCOVA result. The adjusted means of the experimental group and the control group are 4.048 and 3.669, respectively; moreover, the post-questionnaire scores of the two groups reached a significant level with $F = 4.288$ ($p = .044 < .05$), showing a large effect.

Table 1: ANCOVA results of the post-test for the metacognitive awareness inclination

Variance	Group	N	Mean	SD	Adjusted mean	*F*
Mathematics Learning Attitude	Experimental	24	4.100	.565	4.048	4.288*
	Control	24	3.616	.856	3.669	

*p<.05

5. Conclusions and Suggestions

Many researchers have confirmed that digital games can promote learners in the acquisition of learning concepts have a positive effect (Clark et al., 2016; Adams & Clark, 2014; Hsu & Tsai, 2011). In this study, we focus on improving the metacognitive awareness inclination of students by the proposed SDE strategy-based computer game. According to the results, we can easily see that the SDE strategy-based computer game can help learners to raise metacognitive awareness inclination after the learning activities, which means the SDE strategy can help learners to understand the concept in depth, and the process is a constructive activities of self-concept to help learners to link between new learning materials and prior knowledge, and then achieve the learning goals. On the other hand, more gaming experienced learners will be quickly grasp the rules of the game and operation ways. It is suggested that the future researchers can analyze the effect of the learners 'gaming experience.

Acknowledgements

This study is supported in part by the Ministry of Science and Technology of the Republic of China under contract number MOST 105-2511-S-152 -005 -MY2.

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