Yang, J. C. et al. (Eds.) (2017). Extended Summary Proceedings of the 25th International Conference on Computers in Education. New Zealand: Asia-Pacific Society for Computers in Education

Exploring the Effects of Interactive Game with Situational Animation to Facilitate Primary Students in Learning Nature and Life Science

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1. Introduction

As young people spend a prodigious amount of time playing video games either by themselves or with friends, game-based learning has received much attention from educators and researchers (Gee, 2003; Kiili, 2005; Oblinger, 2004). Hwang and Wu (2012) gives a review of the papers published between 2001 and 2010 and shows that game-based learning has been applied to subjects such as mathematics, computer science, geography, and language, mainly because this mode of learning raises the students' interest and motivation. In a well-designed game-based environment, students apply their prior knowledge to the activity while the engaging design heightens their motivation (Papastergiou, 2009; Tao, Huang, & Tsai, 2016; Van Eck, 2006), and supports an active, experiential, and problem-oriented learning environment (Meluso, Zheng, Spires, & Lester, 2012).

To be effective, game-based learning needs a design that is interesting and challenging and steeped with meaning; it induces responses from students (Chuang et al., 2012) and cultivate qualities such as courage, curiosity, self-control, competitiveness, cooperation, and validation (Prensky & Prensky, 2008). For example, Huang, Wu, Chen, Yang, and Huang (2013) investigates the effect of using games on mobile devices to teach addition and subtraction to second graders and finds that this method aids in the students' understanding of the subject and raises their performance.

In addition, multimedia animation is often used in digital learning because it can tell stories with vivid characters and situations (Issa et al., 2013; Liu, Lin, Tsai, & Paas, 2012). Moreover, the dual-coding theory asserts that the learner separates outer stimulations into verbal and visual types and stores them in memory; the connection between these two types of stimulation helps the learner knowledge building during the learning process (Clark & Paivio, 1991). The dual-coding theory has spawned many digital learning materials with multimedia animation (Issa et al., 2013; Liu et al., 2012; Rodicio and Sanchez, 2012). Ghanizadeh and Razavi (2015) shows that when multimedia animation is used to help eighth graders learn English, they show a marked improvement in performance and familiarity with the subject and are more motivated to master the content.

In this vein, this study aims to develop an interactive game in learning subject of nature and life science which equips with situated animation to express the natural theory. This tool facilitates students to question the natural phenomena they learn and lets them interact with objects during playing game. In order to evaluate the effects of the interactive game, the learning performance of fourth graders were conducted in this study.

2. Methods

This study seeks to help elementary school students learn the theories of natural phenomena. The multimedia animation explains the abstract concepts while the interactive game tests the students' knowledge in theories and phenomena.

2.1 Interactive Animation Game

The study proposed an interactive game with situated animation, which based on the Water Movement, a learning unit for fourth graders, complete with 2D characters and props. The unit has three sections: (1)capillary motion, (2)siphon, and (3)u-tube.

The script of the animation is about a kid robot, Xiaobo, and his family. The story starts with Xiaobo playing paper airplanes on the bed. His mother calls and tells him that she is coming home. Xiaobo stops playing and rushes to do the things that his mother asked him to do before she left the house: cleaning up the spilled soda, putting fresh water in the fish bowl, and adjusting the pictures on the wall.

Figure 1. Animated Scenes: (Left) Room before Clean-up; (Right) Room after Clean-up

Figure 1 shows the room before and after Xiaobo cleans it up. Xiaobo wipes the spilled soda with a kitchen towel (Figure 2, left). To show how absorption works, we create a water droplet flowing into a crevice to explain capillary motion (Figure 2, center). When the kitchen towel has absorbed most of the spilled soda, there is less soda on the table (Figure2, right).

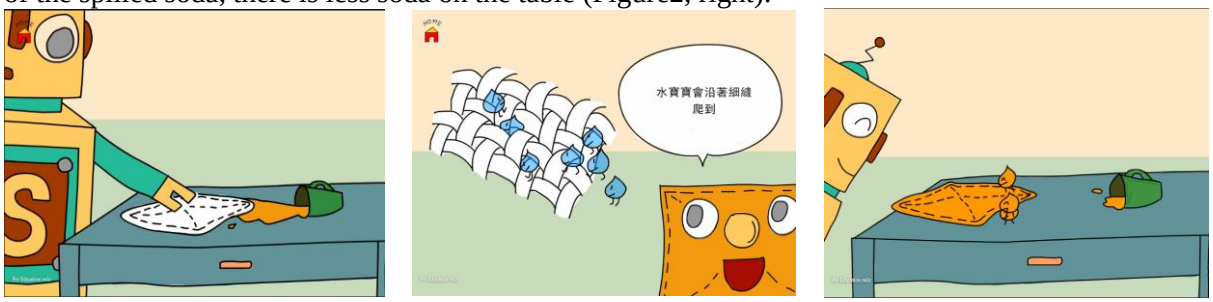

Figure 2. Left: Xiaobo Wiping Table; center: Water Droplet and Capillary Motion; right: Water Movement

2.2 Participants and Activity Procedure

The participants were a total of 52 fourth-grade students at an elementary school in northern Taiwan, divided into an experimental group (n = 28) and a control group (n = 24). The regular teaching for each learning unit was three periods per week and lasted for three weeks. Both experimental and control groups were taught by the traditional classroom and lab activity. Besides, the participants in the experimental group would conduct game learning activities.

2.3 Data Collection and Analysis

The learning outcome was investigated from the pre- and post-tests to find out the changes in participants' learning achievements. Prior to the experiment, both experimental and control groups took a test as the pre-test. After the experiment, both groups were given a test related to the learning contents as the pro-test. The single-factor analysis of covariance (ANCOVA) was used to analyze the changes of the participants' pre- and post-test scores. The pre-test score is considered to be a covariance to analyze the difference between post-tests within the two groups.

3. Results and Discussion

According to the ANCOVA statistical method, the variance homogeneity test was conducted first. Levene's test yielded $P > 0.05$ ($F(1,48) = 3.227$, $P = 0.079 > 0.05$), which means it did not reach the

standard and thus did not violate the hypothesis of variance homogeneity. Applying covariance analysis to the performance of the two groups, the F-value is 3.348 and p-value = 0.073>.05, which is not statistically significant. Thus, the performance of students in the experimental group is not significantly higher than those in the control group. After the adjustment, results of the means and SDs of the post-tests were obtained (control group: M = 86.70, SD = 2.10; experimental group: M = 91.94, SD = 1.94). Even though the ANCOVA did not demonstrate the significant learning improvement between experimental and control groups, the mean of the experimental group reveals progress in learning effects while the control group does not. Moreover, the experimental group's score range is smaller than that of the control group.

The positive influence game-based learning exerts on performance has been testified, while the dual-code theory asserts that imagery improves verbal memory when the mind processes outside stimulations. This game-based leaning model compels the students to have a real-life experience in viewing the multimedia animation while the interactivity tests the students' knowledge. It suggests further study on the experimental group to ascertain the degree to which game-based learning with multimedia animation has positive effect on learner autonomy, attention, and confidence in learning materials.

Acknowledgements

The authors would like to thank the Ministry of Science and Technology in Taiwan for financially supporting under the research project number: MOST 105-2511-S-147-001.

References

Chuang, Tsung-Yen, Shi, Yen-Ru, Tsai, Tsun-Hung, Yang, Chi-Yu, Tao, Shu-Yuan, Ma, Jung-Tsan, . . . Hsu, Yu-Jen. (2012, November 26 - 30). *Uncover the Ambiguity between GBL and CAI.* Paper presented at the The 20th International Conference on Computers in Education (ICCE2012), Singapore.

Clark, James M, & Paivio, Allan. (1991). Dual coding theory and education. *Educational psychology review, 3*(3), 149-210.

Ghanizadeh, Afsaneh, & Razavi, Azam. (2015). The impact of using multimedia in English high school classes on students' language achievement and goal orientation. *International Journal of Research Studies in Educational Technology, 4*(2).

Hogle, Jan G. (1996). Considering Games as Cognitive Tools: In Search of Effective" Edutainment.".

Huang, Shu–Hsien, Wu, Ting–Ting, Chen, Hong–Ren, Yang, Pei–Chen, & Huang, Yueh–Min. (2013). Development of a context–aware game for conducting ubiquitous mathematics learning activities. *International Journal of Mobile Learning and Organisation, 7*(3), 239-252.

Hwang, G.J., & Wu, P.H. (2012). Advancements and trends in digital game- based learning research: a review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology, 43*(1), E6-E10.

Issa, Nabil, Mayer, Richard E, Schuller, Mary, Wang, Edward, Shapiro, Michael B, & DaRosa, Debra A. (2013). Teaching for understanding in medical classrooms using multimedia design principles. *Medical education, 47*(4), 388-396.

Liu, Tzu-Chien, Lin, Yi-Chun, Tsai, Meng-Jung, & Paas, Fred. (2012). Split-attention and redundancy effects on mobile learning in physical environments. *Computers & Education, 58*(1), 172-180.

Meluso, A., Zheng, M., Spires, H.A., & Lester, J. (2012). Enhancing 5th graders' science content knowledge and self-efficacy through game-based learning. *Computers and Education, 59*(2), 497.

Paivio, A, & Representations, A Mental. (1986). A Dual Coding Approach. *New York*.

Papastergiou, Marina. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers & Education, 52*(1), 1-12.

Prensky, M., & Prensky, M. (2008). Digital game-based learning.

Rodicio, H García, & Sanchez, E. (2012). Aids to computer-based multimedia learning: a comparison of human tutoring and computer support. *Interactive Learning Environments, 20*(5), 423-439.

Shute, Valerie J, & Ke, Fengfeng. (2012). Games, learning, and assessment *Assessment in Game-Based Learning* (pp. 43-58): Springer.

Tao, Shu-Yuan, Huang, Yun-Hsuan, & Tsai, Mei-Jia. (2016). *Applying the Flipped Classroom with Game-Based Learning in Elementary School Students' English Learning*. Paper presented at the The Fifth International Conference on Educational Innovation through Technology (EITT2016), Tainan, Taiwan.

Van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *EDUCAUSE review, 41*(2), 16.