Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

Examining Relationship between Biology Attitudes and Perceptions toward Mobile Augmented Reality of Photosynthesis and Impact on Gender Difference

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Abstract: New possibilities for teaching and learning provided by augmented reality (AR) have been increasingly recognized by educational researchers. In science education, AR allows learners to visualize complex spatial relationships and abstract concepts and experience natural phenomena that are not possible in the real world in way of the mixed reality. Due to the abovementioned benefits, a mobile AR represented photosynthesis process has been designed and created for enhancing biology learning by the researchers. 101 eleventh - grade students aging 16-18 years old were recruited to participate in this study, to investigate the relationship between attitude toward biology and perception toward mobile AR and compare the perception towards augmented reality tool within the disparity of gender. They were 71 females and 30 males, and all of them were administered with 25-items biology attitude questionnaire and 18-items perception toward mobile AR. The results of this study suggest that students' perception toward augmented reality technology was not defined by their attitudes toward biology, and the disparity of gender did not effect to perception toward learning with mobile AR technology. This implied that any gender could learn biology of photosynthesis with the use of AR technology, and they could participate to learn biology through mobile AR disregarding biology attitude.

Keywords: attitude, perception, augmented reality, biology education

1. Introduction

Due to the nature of conceptual biology of photosynthesis, the process of photosynthesis is much complicated and difficult to understand by students. In national science curriculum of Thailand, the photosynthesis concepts were placed into lower primary education until upper secondary education, and researchers found that student often hold many alternative conceptions or misconceptions of photosynthesis (Pinatuwong and Srisawasdi, 2014). Regarding to the previous researches such as Kose (2008), and Svandova (2014), these previous studies revealed that most students still have the misconception, for example in the chloroplast only have chlorophyll (Kijkuakul, 2006), and photosynthesis is the same process as plant respiration (Svandova, 2014). They need a special assistance from researchers, educators, or teachers to facilitate their learning on how photosynthesis works for improving meaningful learning in biology.

In context of Thailand, the way to teach biology of photosynthesis in science class is using lecture incorporated textbook, work sheet, or slide presentation. Laboratory work which is perhaps the most essential element and exiting thing about science, but it requires time, effort, experience and expense Thai students generally can be test takers but cannot succeed biology learning with text reading as a result of having difficulty to understand the process of photosynthesis without visualizing the dynamic process and biological mechanism of plant photosynthesis. Sometimes the pictures in text book are inadequate to understanding of biological process of plant.

At present, the technologies has been greatly developed and widely used in improving quality of education. Concurrent with the rapid growth of computers and technologies in the practice of the science education community, contemporary technology-based approaches to science learning offer ample opportunities for students' innovative learning environments for conceptual development (Srisawasdi and Panjaburee, 2015). Suits and Srisawasdi (2013) mentioned the affordabilities of instructional visualization technology, which could support perceptions of students to visualize scientific phenomena both observable and unobservable levels of representation. In recent years, augmented reality (AR) technology is gaining popularity within society and becoming more ubiquitous in nature (Johnson, Smith, Levine, and Haywood, 2010). According to Chang, Morreale, and Medicherla (2010), several researchers have suggested that students can strengthen their motivation for learning and enhance their educational practices with virtual and augmented reality. Several educational uses of AR have already been documented in the literature. AR technology has been used to develop students' understanding of science, including environmental science (Hsiao, Chen, and Huang, 2011), micro-biology (Chen, 2006) and biomedical science (Rasimah, Ahmad, and Zaman, 2011). The use of AR in the classroom has repeatedly been shown to increase student motivation (Billinghurst and Duenser, 2012; Johnson, et al., 2010; Tarng and Ou, 2012). According to the benefits of AR in education, the researchers interest to utilize the AR for enhancing biology of photosynthesis because AR could be used to visualize the photosynthesis process by combining virtual data with real world data which can provide users with access to rich and meaningful multimedia content, that is contextually relevant and can be easily and immediately acted upon (Billinghurst, Kato, and Poupyrev, 2001).

2. Literature Review

2.1 Augmented Reality (AR)

Augmented Reality or AR is the technology blended real world and virtual realistic together via software or other connected devices and then real - time display on the mobile - phone, computer or projector. So player can interact with the image or anything in AR directly. AR can display for 3D, animation, or audio visual based on the designing of programmer. In the current augmented reality is considered as an efficiently pedagogy applications (Cheng and Tsai, 2012). For educational contexts, AR research is relatively in an early stage, there have been a number of research studies that evince cognitive and emotional effects of AR applications on student learning process and outcome. AR technology can enhance learners' understanding of complex objects or situations by presenting a variety of views through 3-dimensional stereoscopic images and virtual simulation infused with the real environment (Han et al., 2014).

2.2 Gender Effect on Science Learning

In the last decades there were many evidences of gender gap in science learning. Soyibo (1999) studied about the different of genders' performance on the biology test. The results showed that the girls had higher score more than the boys significantly. The effects of science interest and environmental responsibility on science aspiration and achievement was investigated by Chiu (2010), the finding showed the positive integrating effect for boys but negative for girls. On the other hand, there were many researches indicated that no significant difference in science learning between the disparity of gender (Piraksa, Srisawasdi and Koul, 2014; Plant et al., 2009)

2.3 Biology Learning of Photosynthesis

Due to the complexity and abstraction of photosynthesis concepts, most of students often hold alternative conceptions about the biology phenomena. In Thailand mostly instructional about photosynthesis were taught by regular classroom. There were some research about teaching photosynthesis with technology such as Pinatuwong and Srisawasdi (2014) used analogy-based simulation for biology learning of light reaction phenomenon, the result showed that the student could perceive this technology even they were positive or negative attitude toward science learning and Nasaro and Srisawasdi (2014) used sensor-based laboratory learning environment incorporated predict-observe-explain (POE)-based ubiquitous learning in photosynthesis topic, the result explicit that the intervention could promote students' self-efficacy and perceived ease of use on the learning. There have no research about augmented reality on photosynthesis yet. So we think the new technology for biology learning cloud improve student attitude toward science and it could develop conceptual understanding in biology topic.

3. Purpose

The aim of this study was to examine relationship between attitude toward biology and perception toward mobile augmented reality application of photosynthesis, and to investigate impact of gender difference on their perception toward the mobile augmented reality.

4. Methods

4.1 Participants

The study was conducted in a large-sized urban public high school located in the northeastern region of Thailand. The total participants consisted of 101 students in their age ranging from 16 to 18 years. 71 of them were female (about 70%) and rest of them was male (about 30%). All of them have ever learned about photosynthesis in regular biology class and the never know about augmented reality. The students who participated in this study were voluntary. They were given no preferential reward for participating.

4.2 Learning Material

In this study, a series of mobile AR of photosynthesis have been designed based on common misconceptions about photosynthesis hold by students. A number of researchers, both international and national journals, were reviewed and then the researchers summarized all common misconceptions. Then, a story board has been created by the researchers and it was sent to computer programmer. The AR app. used in this study was displayed in Figure 1.

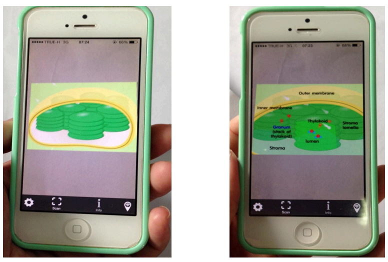

Figure 1. An illustration of mobile AR application: microscopic - represented animation in the mobile AR app (left); and mechanism representation of plant photosynthesis (right).

4.3 Procedure

In the step of pilot study using mobile AR tool in this study, before the leading to the topic of chloroplast in the AR - tool participants took a twenty-five item 5 point questionnaire for determining the attitude toward biology lesson that have already taken the reliability for Thai version (Pinatuwong and Srisawasdi, 2014).The questionnaire was developed including 6 items of interested in biology lessons (IBL), 10 items of understanding and learning biology (ULB), 5 items importance of biology in real - life (IBR), 4 items biology and occupation choice (BOC) toward biology lesson (Ayyildiz and Tarhan, 2013). The students were informed to take the questionnaire for 15 minutes as pretest. Before interact with AR - tool, teacher orientated about using mobile AR application and then student were allowed to interact with the AR by using android phone, iOS phone, or tablets for reading the AR pictorial code for 30 minutes, as displayed in Figure 2.

Figure 2. An illustration of learning activity of photosynthesis through mobile AR application

At the end, the second questionnaire was used to survey the perception to created AR tool. This questionnaire was composed of 18 items including perceived learning (PL), perceived ease of use (PEU), Flow (FL), Perceived playfulness (PP), Enjoyment (EJ), Satisfaction (ST) developed from Tao, Cheng, J.C. and Sun (2009). All students took the questionnaire for 15 minutes as post-test. Data from two questionnaires were analyzed by using Pearson's correlation in SPSS version 21.0 and the perception toward AR tool of each gender were compared by using MANOVA statistic in SPSS 21.0.

5. Result and Discussion

5.1 Correlation between Biology Attitude and Perception toward Mobile AR

The first analysis was Pearson's correlation of IBL, ULB, IBR, BOC toward biology lesson with PL, PEU, FL, PP, EJ, and ST (see Table 1). The results explicated that correlation among PL, PEU, FL, PP, EJ, and ST, illustrates positive correlation significantly (p-value < 0.01), these were like the correlation of perceptions towards technology among IBL ULB, IBR, and BOC (p-value < 0.01). There was no significant correlation between variables of attitudes towards biology and variables of perceptions towards technology; Pearson product moment correlation among BOC, PL, r = 0.203, p-value < 0.05, PEU, r = 0.246, p - value < 0.05, and ST, r = 0.256, p-value < 0.01, nevertheless. Mostly, these finding advise that participants' attitudes towards biology lesson was not controlled by their perceptions towards augmented reality, except some part such as the perceptions about perceived learning, perceived ease of use, and satisfaction depend on the attitudes toward biology about biology and occupation choice; if student prefer to work or use the biology knowledge to created their occupation in the future they would have a good perceptions. The results showed like that because the augmented reality about chloroplast in this version prefers to use the internet for playing the AR code. While the school area had poor internet signal, student might have difficulty to interact with it. This study indicated that augmented reality suitable for supported biology lesson. Cai et al. (2014) created AR marker about composition of substances and tried it out with junior high school, the result presented that augmented reality could enhance learning significantly and most of the students have positive attitude towards augmented reality.

5.2 Perception between Males and Females

The result of this study shows that the disparity of gender did not effect to students' perception toward instructional technology in augmented reality on photosynthesis. Furthermore, any gender could perceive toward this technology Moreover, the mean score in each area of perception of male was

Table 1: Descriptive statistics and Pearson's correlation between biology attitudes and perception toward instructional technology in augmented reality.

Pearson correlation	IBL	ULB	IBR	BOC	PL	PEU	FL	PP	EJ	ST
IBL	1									
ULB	.559**	1								
IBR	.456**	.471**	1							
BOC	.624**	.483**	.394**	1						
PL	0.182	0.126	0.195	.203*	1					
PEU	0.153	0.176	-0.032	.246*	.427**	1				
FL	0.078	0.18	-0.014	-0.01	.408**	.486**	1			
PP	0.044	-0.009	0.083	0.072	.570**	.329**	.593**	1		
EJ	0.147	0.081	0.081	0.144	.451**	.311**	.430**	.586**	1	
ST	0.141	0.034	0.183	.256**	.632**	.356**	.348**	.628**	.555**	1
Mean	18.34	31.01	18.15	13.67	11.95	7.29	10.23	11.2871	7.81	19.86
SD	3.22	3.57	3.08	2.64	2.02	1.54	2	1.86192	1.36	3.27

*** p - value < 0.01,*

** p - value < 0.05*

similar to females' mean score, satisfaction has the highest mean score of any area of perception (about 20 points). The PL and PP were estimated 15 points, and PEU, FL, EJ have about 10 points. The satisfaction, perceived playfulness, flow, and enjoyment connect to the interest-driven creator theory (IDC), especially the interest loop, there were linked with the triggering, immersing, and extending, component of interest loop. This finding indicated that the instructional technology in augmented reality on photosynthesis can promote the students' interested.

6 Conclusion and Implication

Overall finding of this investigation suggests that students' perception toward augmented reality technology was not defined by their attitudes toward biology, and even though they have disparity of gender but it did not effect to perception toward augmented reality technology. The result showed all participants have the same perception to augmented reality. The participants have satisfaction toward this technology highly.

This was the pilot study. In the next study we prefer to use augmented reality on refutation text combine with the model-based inquiry pedagogy to promote a deep understand in the concept of photosynthesis and the critical thinking skill. The reason for chosen the refutation text is, challenge to misconception that usually consists of two main parts, the first part is a message that is all misconceptions and the second part is a text by clearing misconception which scientific explanation. Reading refutation text could foster effective conceptual change more than reading regular text (Sodervik et al., 2013). In the pedagogy of the next study, we will allow student to predict about phenomena that occur in process of photosynthesis by drawing or explaining on their worksheet. After that they interact with learning materials and the last they must be draw, explain or create their understanding in the same worksheet. This instructional can prompt student to create or organize their knowledge like the creating loop of IDC theory that consist of imitating (draw or explain after interact with AR material), combining (organize their knowledge) and staging (picture or description on worksheet).

Acknowledgements

This work was financially supported by The Institute for the Promotion of Teaching Science and Technology (IPST) and Graduate School, Khon Kaen University. The author would like to express gratefully acknowledge to Faculty of Education, Khon Kaen University, for supporting this contribution.

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