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An Investigation of Relationships between Biology Attitudes and Perceptions toward Instructional Technology in Analogy-based Simulation on Light Reaction

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Abstract: Computer-simulated scientific phenomena have become an indispensable tool in modern scientific investigations and in contemporary science class. In context of science-based education, computer simulation or visualization are now commonly used to promote student's meaningful understanding in science concepts, and motivation to learn science. This study presents the development of an analogy-based simulation, as a novel pedagogy-oriented simulation, for biology learning of light reaction phenomenon. 46 eleventh-grade students were recruited to participate interacting with the analogy-based simulation. The 25-item Likert-scale questionnaire on attitude toward biology lesson scale was administered to the student before interacting the simulation, and another 21-item Likert-scale questionnaire on perception toward instructional technology was completed by the student after the interacting. Overall finding of this study suggests that students' attitudes towards biology did not determine their perceived learning, flow, enjoyment, perceived ease-of-use, perceived usefulness, and satisfaction, delivered by the analogy-based simulation. As such, this study concludes that the analogy-based simulation could be used in biology class disregarding students' attitudes toward biology. The findings could be implied for designing effective computer simulation to facilitate biology teaching and learning in school science.

Keywords: Computer simulation, analogy, perception, attitude, biology education

1. Introduction

Currently, the prospect of research on the use of ICT in education in general, or even in the specific case of science education is widespread, especially studies on the use of computer simulations. Nowadays, computer simulation has become increasingly powerful and available to teachers in the past decade (de Jong, Linn and Zacharia, 2013; Trundle and Bell, 2010). For instructional context, computer-simulated technology has been used to facilitate teaching and learning by visualizing objects, processes, and interact dynamics models of natural phenomenon, that are normally beyond the user' control in the natural world (de Jong, Linn and Zacharia, 2013; Perkins et al., 2006; Wieman, Perkins and Adams, 2008). These technology offer idealized, dynamic and visual representations of invisible phenomena and experiments which would be dangerous, costly or otherwise not possible in school laboratories (Hennessy, 2007). Since, simplified versions of the natural world were showed by computer simulation, students' attention can be more focus directly on the desired phenomenon (de Jong and van Joolingen, 1998; Perkins et al., 2006; Wieman, Perkins and Adams, 2008).

As such, successful concepts of simulation-based teaching and learning have been reported by means of discovery learning (de Jong, Linn and Zacharia, 2013) and inquiry-based learning (Perkins et al., 2006; Wieman, Perkins and Adams, 2008). The researchers have interested to science learning with analogy, which is an effective pedagogy to assist students learning about an unfamiliar concept, system, or process, called *target* by means of its relationship to a familiar concept, system, or process,

called *analog*. Based on literature reviewing, very few study (i.e. Ashe and Yaron, 2013; Ünlü and Dökme, 2011) has investigated effects of analogy-based simulation that may influence students' conceptual development in science. Especially, considering to the nature of biology knowledge, lot of invisible processes and biological mechanism that occurred in organisms was presented to student and they encountered with learning difficulties about biology. Teaching biology through analogy is an instructional idea with aim to help student learn biology meaningfully. Schiff (1970) stated that perception and attitudes were related together in which attitudes affect perception, perception affects attitudes, and cognition plays a role in both of them. An important consequence of instruction is the student's attitude toward the subject and the previous study found that there is usually positive correlation between attitudes and achievement, but researcher cannot assume a positive attitude on the basis of achievement alone (Russell and Hollander, 1975). It is possible for a student with low achievement to have developed a very positive attitude toward the subject matter, but it is also possible that a student who indicated on post-test that they have learned the subject matter well may also have learned to dislike or, worse yet, hate the content (Russell and Hollander, 1975). From these reasons, the researchers have created a computer simulation emphasized analogy approach on biology concept of light reaction and an evaluation of students' perception towards the simulation regarded their existing biology attitudes.

2. Analogy-based Simulation

Analogy-based simulation is computer-simulated visualization that does not directly depict atoms or molecules; rather, they simulate a different physical system that relates to a chemical system or concept by analogy. For examples, Ashe and Yaron (2013) created computer simulation visualized chemistry phenomena by making analogies between chemical systems and familiar objects from students' everyday experiences, e.g. boxes, steps, and balls. Because students are not typically experienced in reasoning qualitatively about chemical systems, the analogy-based simulation aims to leverage students' experience with the world around them to help them better understanding of scientific concepts (Ünlü and Dökme, 2011). As the way it was created and students are interactive and dynamic by their nature, analogy-based simulations are likely to be more engaging to students than static, non-interactive presentations of analogies. Moreover, since students cannot benefit from an analogy if they do not engage with it, simulations may offer an advantage here. There are dual-situated events in which analogy could be used to incorporate into computer simulation. Firstly, analogies were used to simulate concepts which are not possible to simulate directly with portrayal of atoms or molecules, or which could be simulated more clearly by analogy. Another, analogy could be used to address students' understanding for important knowledge abstractions (Ashe and Yaron, 2013).

3. Methods

3.1 Participants

A total of 46 student-respondents in their eleventh grade, age ranging from 16 to 17 years in a local public school at the Northeastern region of Thailand participated in this study. They have no experience yet using analogy-based simulation. This implied that they are heterogeneous before interacting with the simulation.

3.2 Learning Materials

Figure 1 illustrates examples of analogy-based simulation on light reaction phenomenon of plant photosynthesis. As aforementioned, target and analog are important concepts for analogy approach, and both were created into the computer simulation. In this analogy-based simulation, the target event was electron transfer during photosystem I (PS-I) of light reaction and the analog event was coal transfer on a pirate ship. In an addition, there were two parameters which student could vary for their investigation; wavelength of light and light intensity.

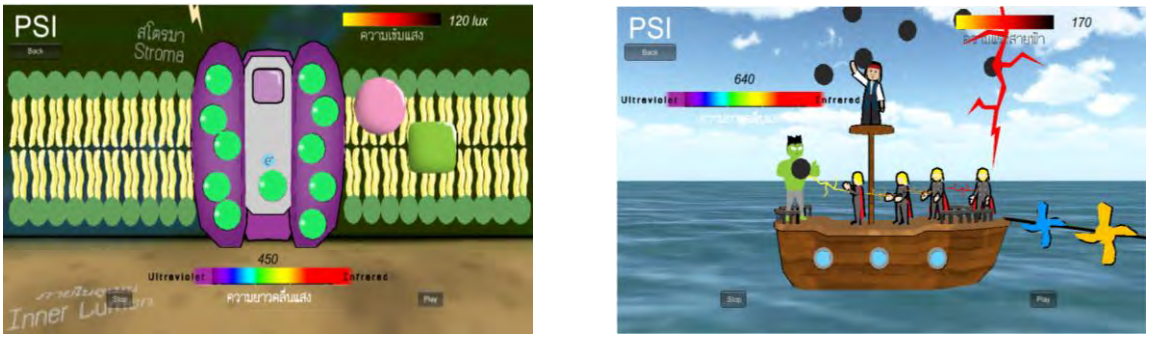

Figure 1. Illustrative example of target (Left) and analog (Right) event in analogy-based simulation.

3.3 Procedures

Before exposing to the analogy-based simulation, the students took a 25-item five-point Likert-scale questionnaire on attitude toward biology lesson scale for 10 minutes. A 25-item Likert-scale questionnaire was developed to use in this study for examining students' interest in biology lessons (IBL), understanding and learning biology (ULB), importance of biology in real-life (IBR), biology and occupational choice (BOC) toward biology learning. There were six items of IBL, 10 items of ULB, five items of IBR and four items of BOC (Ayyıldız and Tarhan, 2013). To develop a Thai version of the questionnaire, the original English version was translated identically in Thai language. One expert was recruited to identify communication validity of the items. On each item, respondents were assigned to rate how the respondent agree with into five scale, from 1-strongly disagree to 5-strongly agree. The reliability for Thai version on IBL, ULB, IBR, BOC was 0.79, 0.70, 0.70, 0.65 respectively, and the overall was 0.76. To experience with the analogy-based simulation, they were assigned to interact with the simulation independently for 30 minutes. After that, the students took 21-item five-point Likert-scale questionnaire measured perception toward instructional technology for 10 minutes. The questionnaire was developed to examine students' perceived learning (PL), flow (FL), enjoyment (EJ), perceived ease of use (PEOU), perceived usefulness (PU), and satisfaction (ST). There were four items of PL, five items of FL, three items for EJ obtained from Barzilai and Blau (2014), and three item of PEOU, three items of PU, three items of ST obtained from Cheng (2014). The reliability for Thai version on PL, FL, EJ, PEOU, PU, ST was 0.80,0.82, 0.75, 0.74, 0.84, 0.77 respectively and the overall was 0.95.To examine correlation between students' attitude and perception toward instructional technology, Pearson's correlation was performed in SPSS 21.0.

4. Results and Discussion

Table 2 shows Pearson's correlations among the variables. Regarding the Pearson's correlation analysis of attitudes towards biology, the results indicated that correlation among PL, FL, EJ, PEOU, PU, and ST, reveals a significant positive correlation (p-value < 0.01), as well as the correlation among IBL, ULB, IBR, and BOC in perceptions towards instructional technology (p-value < 0.01). However, there was no significant correlation between variables of attitudes towards biology and variables of perceptions towards instructional technology, except the product-moment correlation between perceived ease of use (PU) and interest in biology lessons (IBL), r=0.294, p-value < 0.05. For the overall summarization, these findings suggest that students' attitudes towards biology did not determine their perceptions towards instructional technology delivered by the analogy-based simulation. This means the use of analogy-based simulation for biology learning could support students' perceptions even individual student who have a positive or negative biology attitudes. This evidence consistent with previous research finding that students perceived learning with simulation offer instructional advantages and they can gain benefits for their experiences (Baillie and Curzio, 2009; Prokop, Prokop and Tunnicliffe, 2007). Furthermore, the use of instructional technology could be a challenge in teaching methods for providing interactive classroom activities and stimulate students' engagements and attitudes toward science (Hansen and Birol, 2010).

Table 1: Descriptive and Pearson product-moment correlation matrix of attitudes towards biology lesson and perceptions towards instructional technology.

variable	PL	FL	EJ	PEOU	PU	ST	IBL	ULB	IBR	BOC
PL	-									
FL	.773**	-								
EJ	.783**	.764**	-							
PEOU	.715**	.753**	.732**	-						
PU	.773**	.758**	.781**	.779**	-					
ST	.711**	.611**	.701**	.720**	.732**					
IBL	.188	.273	.163	.097	.294*	.147	-			
ULB	.041	.167	.238	-.009	.117	.100	.501**	-		
IBR	.058	.104	.005	.028	.125	.144	.647**	.454**	-	
BOC	.068	.261	.138	.062	.262	.109	.866**	.487**	.616**	-
Mean	16.61	19.72	12.70	12.02	12.26	12.59	21.11	31.80	17.80	13.74
SD	2.55	3.13	1.90	2.04	2.08	1.81	3.70	5.59	2.76	2.49

** *p*-value < 0.01; * *p*-value < 0.05

5. Conclusion

To facilitate students' learning in biology, an analogy-based simulation was created to assist students learning about an unfamiliar concept, system, or process. The result indicated that the use of analogy-based simulation for biology learning to students could be benefits on their perceptions even holding a positive and negative attitude towards biology lessons. Thus, it is crucial to design computer-simulated visualization by the use of analogy approach to scaffold students' perceptions. To this end, researchers should pay more attention on principle of analogy when designing computer simulation to enrich the learning content for biology learning in school science.

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