Evaluation of Secondary School Students' Perceptions toward Combination of Digital Learning Technology for Physics Learning

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Abstract: With rapid growth of digital learning, researchers revealed that the digital technologies for teaching and learning could promote students' interest, motivations, attitudes, and enhance conceptual learning outcome. According to this evidence, an educational computer game and a computer simulation were chosen as important digital learning technology in physics learning in this study. Moreover, perceptions of perceived learning, perceived ease of use, perceived playfulness, enjoyment, perceived satisfaction, and flow were chosen as important factors in learning physics with gender differences through the physics lesson. Fifty-one students in Northeast region of Thailand were recruited to interact with the digital learning technology to investigate the effect of perception toward science lesson. Before participating in the learning activities, a Likert-scale perception was administered to the students as a pre-test. After finishing the learning activities, the Likert-scale perception was administered to the students as a post-test. The results indicated that females and males increased their perceptions on perceived learning, perceived ease of use, perceived playfulness, enjoyment, perceived satisfaction, and flow after interacting with digital learning technology; moreover, females showed positive perception more than males.

Keywords: Educational computer game, computer simulation, gender differences, perceptions, science education

1. Introduction

In the past decade, the researchers revealed that the important digital learning technologies in improving quality of education and preparing new generation to have skills in 21st century society were educational computer game (Dorji, Panjaburee and Srisawasdi, 2015; Hwang, Chui and Chen, 2015; Moreno-Ger, Burgos, Martínez-Ortiz, Sierra and Fernández-Manjón 2008; Lee and Chen, 2009) and computer simulation (de Jong and van Joolingen 1998; Rutten et al. 2012; Srisawasdi and Panjaburee, 2015; Vreman-de Olde et al. 2013). Those researchers concluded in the same way that the students improved their learning performance and experience, and attitudes through learning activity with such digital learning technologies.

In the previous studies, researchers revealed that digital game-based learning could promote students' interest, motivation, attitude, and enhance conceptual learning outcome and explained how digital game support students' motivations and learning achievement (Giannakos, 2013; Lokayut and Srisawasdi, 2014; Nantakaew and Srisawasdi, 2014). Interestingly, the experimental results showed that the inquiry-based educational computer game significantly improved the students' learning achievement on energy consumption as well as their awareness on electric energy conservation (Dorji, Panjaburee, and Srisawasdi, 2015). In an addition, using computer game in education reported that it increased students' perceptions regarding learning, flow, and enjoyment in the game (Barzilai and Blau, 2014; Huang and Johnson, 2008; Hwang, Sung, 2012; Hwang, Sung, Hung, Huang and Tsai, 2012; Liu and Chen, 2010). Not only the educational computer game could promote learning performance and

motivation but also the computer simulation has been growing in supporting learning, especially, in discovery learning (Egenfeldt-Nielsen, 2005; Michael and Chen, 2006).

Computer simulations which contain visualization and features for representing an authentic system or phenomenon and they have a number of features has been recognized as an effective tool for teaching and learning method in science (Blake and Scanlon 2007; Wellington 2004). As such, computer simulation can help students to engage productively in physical sciences lessons and are referenced as appropriate tools for promote students engagement (Khan, 2011). Insummary, the computer simulations can be effective instructional practices in promoting science content knowledge, developing process skills, and facilitating conceptual change and flexibility, safety, and efficiency deserve attention (Smetana and Bell, 2012) and promoting students' perceptions of learning (Kamtoom, Srisawasdi, 2014).

Since, scientific knowledge is abstract and often complex to learn. Both educational computer games and computer simulations could cope that abstraction and improve learning performance and promote perceptions. However, learning perception through the learning environment with integration of the education computer game and computer simulation has not addressed yet. Moreover, the successful usage of those digital learning technologies depends on the features, the learning strategies, and human factors. Among various human factors, gender difference play an important role in learning using digital learning (Paraskeva, Mysirlaki and Papagianni, 2010). In summary, the perceptions of each gender toward the learning environment with integration of the education computer game and computer simulation has not investigated yet. Based on these concerns, this study aims to cope in this uninvestigated area.

2. The Combination of Educational Computer Game and Computer Simulation

For the purpose of this study we used an educational computer named energy consumption and conservation game (Dorji, Panjaburee and Srisawasdi, 2015) and computer simulation named circuit construction kit of PhET. Figure 1 shows the collaborative learning environment of the students interacting with the computer game and computer simulation. The students are divided into teams of two people for one computer. Starting from the interaction with the computer simulation and the last computer games.

Figure. 1 Illustrative of classroom learning activity through digital technology
By simulations (Left) and computer game (Right)

Figure 2 shows an example of computer simulation representing the equation form of Ohm's law related to a simple circuit. The students can adjust the voltage and resistance, and see the current change according to Ohm's law.

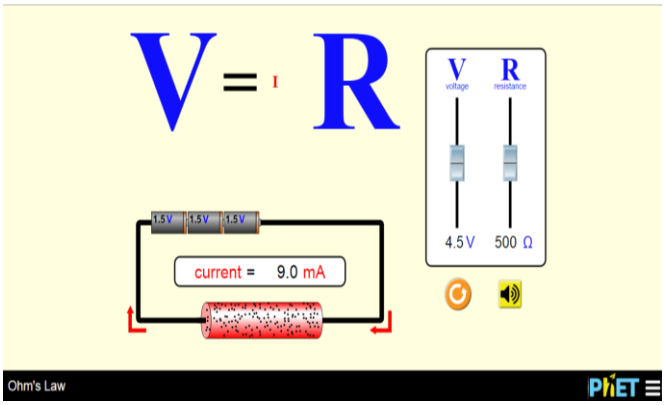

Figure. 2 Illustrative of Ohm's Law simulation (obtained from PhET) for computer-simulated interaction

In addition, Figure 3 shows an example of computer games part which lets the students to solve cases to find out the factors for energy consumption by our daily household electrical appliances in game case 1: identify the factors for energy consumption-factor 1 and game case 2: identify the factors for energy consumption-factor 2.

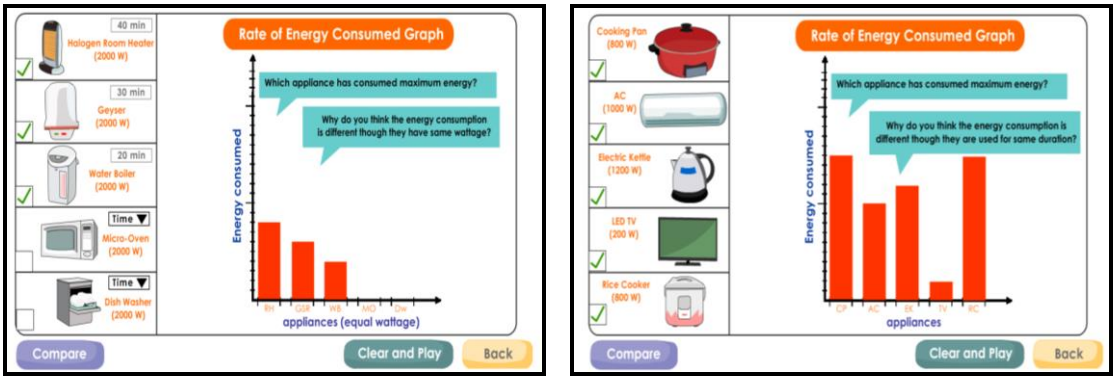

Figure. 3 Illustrative Explore energy consumption factors in electrical appliance by using "energy detective game" by Game case 1: Finding the first factor (Left) and Game case 2: Finding the second factor (Right)

3. Method

3.1 Participants and Research Instruments

The participants in this study were seven-grade students (13-14 years old) in Thailand. A 21-item Likert-scale questionnaire was developed to use to collect data in this study for examining gender difference among perceived learning (4 items), enjoyment (3 items) perceived flow (4 items) obtained from Barzilai and Blau (2014), and perceived playfulness (3 items), perceived ease of use (3 items), and perceived satisfaction (4 items) obtained from Cheng (2014). To develop a Thai version of the questionnaire, the original English version was translated identically in Thai language. Two experts were recruited to identify communication validity of the items. On each item, respondents were assigned to rate how much the respondent agree with into five scale, from 1-strongly disagree to 5-strongly agree.

3.2 Data Collection and Analysis

Students were investigated perceptions by using the 5-point Likert-scale perception questionnaire before experiencing the simulation and the game intervention for 10 minutes as pre-test. Both learning environments, students participated to interact with them for 40 minutes. After the instruction, students were administered by the same questionnaire again as post-test. The statistical data techniques selected for analyzing students' perceptions was repeated-measures MANOVA in SPSS 22.0.

4. Results and Discussion

The results for the repeated-measures MANOVA was conducted to determine students' perceptions scores. The assumption of homogeneity of variance-covariance was tested with Box's M Test which was not significant and indicated that homogeneity of variance-covariance was fulfilled (p = 0.088). The results for the repeated-measures MANOVA indicated significant main effect for gender (Wilks' lambda = 0.671, $F_{(6, 44)}$ = 3.599, p = .005, η^2 = 0.329) and time (Wilks' lambda = 0.504, $F_{(6, 44)}$ = 7.205, p = .000, η^2 = 0.496). Also, there was significant interaction effect between gender and time (Wilks' lambda = 0.753, $F_{(6, 44)}$ = 2.411, p = .042, η^2 = 0.247). Thus, these results indicated there was significant interaction effect between females and males, significant interaction effect time and indicated that the students had increased their positive perception towards through the proposed digital technologies. Univariate analyses of variances (ANOVA) on each subscale were conducted as follow-up tests to the one-way MANOVA. The results of the univariate test for time are summarized in Table 1.

Table 1: The students' subscale means of perceptions by time and univariate MANOVA

Subscales	Tests		$F_{(6, 44)}$	Sig.	η^2
	Pre-test Mean (SD)	**Post-test** Mean (SD)			
Perceived learning (PL)	11.20 (1.93)	14.04 (2.72)	33.343	.000**	0.405
Perceived ease of use (EU)	8.78 (2.17)	9.76 (2.41)	6.123	.017*	0.111
Perceived playfulness (PP)	9.12 (2.14)	10.14 (2.33)	30.513	.000**	0.384
Enjoyment (EJ)	9.69 (2.21)	10.73 (2.19)	4.656	.036*	0.087
Perceived satisfaction (PS)	12.94 (2.93)	14.90 (2.50)	6.850	.012*	0.123
Flow (FL)	10.31 (2.64)	12.88 (2.27)	15.123	.000**	0.236

*$p < 0.05$, **$p < 0.001$

Moreover, Figure 4 illustrates a graphical data showing the pre-test and the post-test of six perception dimensions. The trend of the graph indicates that there is a positive perceptions in learning to participate the digital technologies from the pre-test and post-test.

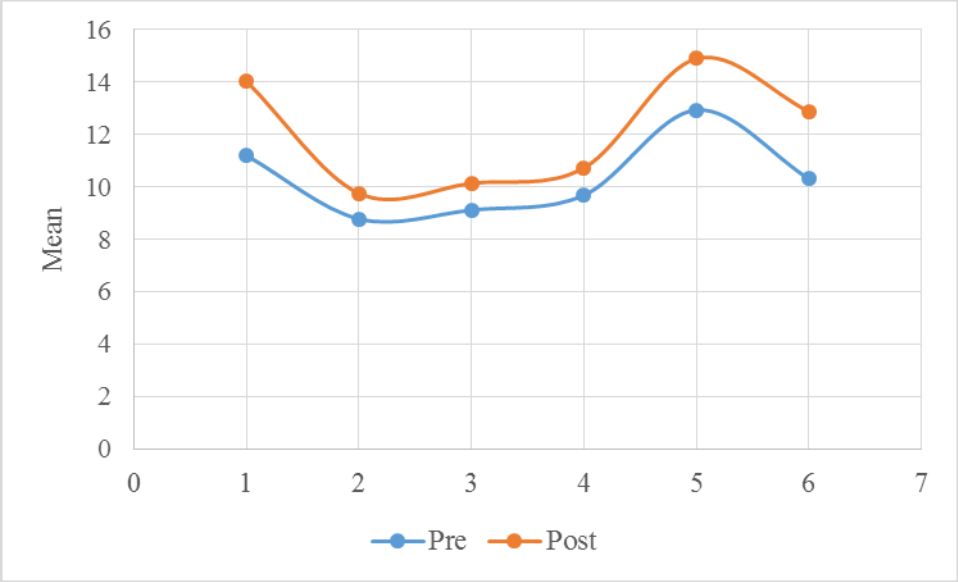

Figure. 4 Compare mean score between pre- and post-questionnaire of five scales of six perception dimension

These results consistent with findings that the computer game can improve the students' conceptual understanding progression and enjoyment and intention to use with the game for males and females (Panjaburee, Dorji and Srisawasdi, 2014). In an addition, it confirms with previous studies (Lokayui and Srisawasdi, 2014) that game could enhance students' perceptions. And it confirms with previous studies (Buyai and Srisawasdi, 2014) that computer simulation could be used to promote students' physics learning experience in which the perception of student increased. The computer game and the computer simulation are digital technology to promote perceptions of students for both females and males meaning that they makes both female and male student had playfulness and content interest.

5. Conclusions

This study reported impacts of learning environment combining with the educational computer game and computer simulation on female and male students' perceptions. The findings revealed that gender difference has effect on students' perceptions towards learning of science through learning environment combining with the educational computer game and computer simulation. As such, it is clear that both females and males increase their on perceived learning, perceived ease of use, perceived playfulness, enjoyment, perceived satisfaction, and flow after interacting with the learning environment in physics course. The results from this study could lead us to conclude that the learning environment combining with the educational computer game and computer simulation can be an alternative way for promoting science learning and female and male students' perceptions in school.

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