An Exploration of Relationship between Motivation and Perceptions in Physics Learning of Light through Game-like Simulation and Its Impact on the Gender Gap

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Abstract: With regarding the benefit of digital game-based learning in promoting students' motivation to learn science and the potential of computer simulation in visualizing invisible features of scientific phenomena, this study conducted a pilot study by implementing an innovative learning environment, called "game-like simulation" for promoting secondary school students' physics learning about light phenomena. The aim of this study was to examine the relationship between physics motivation and perception toward the game-like simulation of light. 86 eleventh-grade students were recruited to participate in this study. The results indicated that there was a significant correlation between physics motivation and perception toward the game-like simulation. The results showed that intrinsic motivation was not related to enjoyment; career motivation was not related to perceived playfulness; self-efficacy was not related to perceived playfulness and enjoyment. In additions, the findings showed that there was an impact of gender difference on perceived ease of use. Moreover, the students trend to have positive perception of physics learning after interacting with the simulation. To the last, finding of this research implied that the game-like simulation could be used to promote students' learning in physics of light by regarding existing physics motivation.

Keywords: Digital game for education, physics motivation, perception

1. Introduction

Currently, the effect of technology influences to human in daily life has been investigated. From the part, instructional education was learning with text-book which is obsolete learning, the most instruction was learn from a book in which information is static. Also, technology has been developed for instructional education such as educational computer game and computer simulation. Educational computer game is digital technology industries and digital gaming immerse several environments. In addition, computer simulation has become increasingly powerful and available to science teachers over the last three decades (Srisawasdi and Kroothkeaw, 2014). The principal features of educational game are challenging to achieve the outcomes, rewarding to engage and motivation and give a situation in which learner plays as the players (Meesuk and Srisawasdi, 2014; Papastergiou, 2009). In recent years, researcher developed digital games for developing students' problem solving and learning motivation. For example,

Yang (2012) revealed that the digital game could foster students' learning motivation and problem solving. Moreover, game-based learning approach had significant effectiveness in improving the students' learning performance (Sung and Hwang, 2013). In other hands, computer simulation, which can display microscopic level or high abstract of things for the better students' learning, can help students adjust variable in simulation and observe the phenomena (Chen-Chung Liu, 2011). However, the computer simulation does not have challenge. Such that the digital game-based learning might address this issue. Moreover, blending the digital game and computer simulation has been challenging to support students' learning (Borro-Escribano, Del Blanco, Torrente and Fernández-Manjón, 2013).

Although, there are many digital games that can use to support the learning of physics. The students still lack of ability to construct knowledge. Because the games only include information without learning by doing. In fact, physics not only has lecture-based but also has laboratory. Therefore, using learning environment combining the digital game and computer simulation called game-like simulation might help students increase learning performance, motivations, and perceptions in physics learning. In other words, the aim of this research is to employ the game-like simulation as an inquiry tool to support learning physics in the light topic. Specifically, the research questions were following:

- How do game-like simulation influence students' perception?
- How are the influences of gender toward perceptions after playing the game-like simulation?

2. Literature Review

2.1 Digital game-based Learning

The new media and digital technology industries and digital gaming engage several environments, especially in educational environment. Digital games consist of dazzling and sophisticated images and sounds, alongside textual communication. Players get engagement which is both pleasurable and challenging. The educational digital game keep players immersed in digital worlds, knowledge, information, and skill development become increasingly accessible outside confines of formal education (Castell, Jenson and Taylor, 2007). Currently, educators used the digital game involving content of subject matter for educational objective. Many researches presented empirical evidences that the educational digital games have positive effect on student learning.

From the past, game create only for entertainment but recently educational researchers have attempted to apply games for learning which call educational games or serious game and use to study in classroom (Sorensen and Meyer, 2007; Stone, 2009). The game that composed of challenge, control, curiosity and fantasy could motivate persistence and enjoyment (Toro-Troconis and Partridge, 2010). The educators have developed games for three objectives such as students can learn from playing the game, students' learning can be encouraging from an apart of game and students have motivation to learn when they learning by playing the game (McNamara, Jackson, & Graesser, 2010). Game-based learning is a master of constructivist-based active learning. Based on the learning research, Watson, Mong and Harris (2011) found that using game in classroom made a shift of teaching from teacher-centered learning environment to student-centered learning environment.

2.2 Computer Simulation

Computer simulations can more increase and available to science teachers. In instruction of computer simulation is visualized in a cognitive level for encourage students' learning in science classroom which displays dynamic data or simplified form in real-world, processes and provide students to observe, explore, create, and receive feedback about data, phenomena and processes such as simulation-based conceptual learning tools were utilized to support activities of observation, and reflection helps in facilitating the learning of abstract concepts (Chen et al. 2011; Colella, 2000; de Jong and Van Joolingen, 1998) and providing data in real-time shows related to a dynamic data on how certain parameters change synchronously to accommodate thinking of high level (de Jong and van Joolingen, 1998; Ronen and Eliahu, 2000).

3. Methods

3.1 Participants

This research joined up 86 students who are studying in eleventh grade and range of age is between 17 and 18 years in a local school at northeast region of Thailand. Program which is science and technology in the classroom is enrolled by them. Properties of light was not taught in the semester when the experiment was conducted.

3.2 Research instruments

This study used two instruments that is questionnaire for explore physics motivation of student and perception toward game-like simulation. First, the questionnaire of motivation scale has 25 items by developing from Science Motivation Questionnaire (Srisawasdi, 2013). This instrument was a Likert-type scale putting items that five motivation components such as Intrinsic Motivation (IM) that consists of five items, Career Motivation (CM) that is consists of five items, Self-determination (SD) that consists of five items, Self-efficacy (SE) that consists of five items, and Grade Motivation (GM) that consists of five items. Students answer the questionnaire to each item on a five-point-scale of ranging from "never" (1 point) to "always" (5 point). Table 1 shows example information of item on the questionnaire.

Table 1: Subscale description and sample items of the Physics Motivation Questionnaire (Srisawasdi, 2013)

Subscale	Description	Sample items
IM	Which involves learning physics for its own sakes	Learning physics is interesting.
CM	Which involves learning physics as a means to an end	Understanding physics will benefit me in my career.
SD	Which refers to students' confidence that they can achieve well in physics	I put enough effort into learning physics.
SE	Which refers to students' confidence that they can achieve well in physics	I believe I can master physics knowledge.
GM	Which refers to the debilitating tension	I like to do better than other students on

	some students experience in association with grading in physics	physics tests.

Second, the students' perception questionnaire was developed by Tao & et al. (2009) that have six components such as Perceived learning (PL) that consists of three items, Perceived ease of use (PEU) that consists of two items, Perceived flow (PF) that consists of three items, Perceived playfulness (PP) that consists of three items, Enjoyment (E) that consists of two items and Satisfaction (S) that consists of five items. Table 2 shows that subscale description and sample items of the students' perception questionnaire.

3.3 Learning Material

The game-like simulation is designed and named "LIGHTs". It was implicated to content of lights' properties. The game defines twelve missions to students. However, this research provides three missions to students for the exploratory phase. The style of the game is shooting game. The goal of this game wishes students understand concept of lights' properties (reflection) and provides information about lights' properties. Actually, students were asked to interact with the game. Figure 1 presents overall learning activity through the game. Moreover, Figure 2 shows examples of user interface.

3.4 Data Collection and Analysis

The participants consist of 86 students. The researcher provides physics motivation questionnaire to students around 15 minutes. After finishing the questionnaire, they played the game around 20 minutes. After finishing the game, the students were asked to complete the perception questionnaire. The data was analyzed using SPSS 22.0 to depict correlation between motivation toward physics and perception toward the game-like simulation.

Figure 1. Learning circumstance through the LIGHTs

Table 2: Subscale description and sample items of the students' perception questionnaire.

Subscale	Description	Sample items
PL	Extent to which student can get the new understanding, subjective evaluation of learning by learners themselves.	• The game-like simulation allows me to complete my studies faster. • The game-like simulation increases

Subscale	Description	Sample items
		my learning efficiency.
PEU	Extent to which using to easy and help to science easier.	• The game-like simulation is easy to use. • Using the game-like simulation to complete course related tasks are easy.
PF	Extent to which a state of deep concentration in which thoughts, intentions, feelings, and all of the senses are focused on the same goal	• I was very involved in the game-like simulation. • When I played I did not think of anything else.
PP	Extent to which students feel happy and attentiveness.	• It is interesting to use game-like simulation. • I feel like exploring more information when I use game-like simulation.
E	Extent to feeling of student when used game-like simulation.	• I had fun playing the game-like simulation for learning science. • I feel relaxed to use game-like simulation for learning science.
PS	Extent to which the individual awareness of how well a learning environment supports academic success.	• The use of the system makes this learning activity more interesting. • I like to learn new skills by using business simulation game-like simulation.

(a) (b)

(c) (d)

Figure 2. Example of physics learning activity on properties of light: (a) display shows starting game; (b) After click to play game, student has to select mission that each to mission sets minimum of stars for pass to play game; (c) After click to select the mission, this game provides the story about light; (d) this chapter provides student play game by using light to reflect reach a goal of this game

4. Results

4.1 Correlation between physics motivation and perception toward game-like simulation of light

This research investigated the correlation between motivation toward physics and perception toward the game-like simulation. Table 3 displays Pearson's correlation of motivation toward physics questionnaire such as Intrinsic Motivation (IM), Career Motivation (CM), Self-determination (SD), Self-Efficacy (SE) and Grade Motivation (GE) and of perceptions toward game-like simulation such as Perceived Learning (PL), Perceived Ease of Use (PEU), Flow (F), Perceived Playfulness (PP), Enjoyment (E) and Satisfaction (S).

Observing Table 3, Intrinsic Motivation (IM) was not related to Enjoyment (E). Career Motivation was not related Perceived Flow. Self-Efficacy (SE) was not related to Perceived Flow (PF) and Perceived Enjoyment (E). These results specified that the students had positive motivation to learn physics and positive perception toward game-like simulation. it suggested that the game-like simulation could be used for some students even if they have a negative or positive motivation toward physics.

The findings from the past research exposed that the educational computer game improves perception motivation of student in context of digital game-based learning experience (Meesuk & Srisawasdi, 2014; Nantakaew & Srisawasdi, 2014). But we do not know about the

correlation between motivation toward physics and perception toward game-like simulation. In this study shows that the results specified that perception toward the game-like simulation does depend on motivation toward physics except to Intrinsic Motivation (IM), Career Motivation (CM) and Self-Efficacy (SE). Also students negative or positive motivation toward physics except to Intrinsic Motivation (IM), Career Motivation (CM) and Self-Efficacy (SE), they could learn physics by the game-like simulation.

Table 3: Correlation between motivation toward physics and perception toward game-like simulation

Subscale	IM	CM	SD	SE	GM	PL	PEU	PF	PP	E	S
IM	1										
CM	.589**	1									
SD	.605**	.479**	1								
SE	.641**	.434**	.595**	1							
GM	.448**	.394**	.462**	.580**	1						
PL	.505**	.301**	.345**	.389**	.235*	1					
PEU	.445**	.341**	.379**	.359**	.308**	.666**	1				
PF	.230*	.177	.266*	.167	.252*	.668**	.574**	1			
PP	.487**	.344**	.454**	.355**	.346**	.722**	.696**	.695**	1		
E	.188	.272*	.292**	.068	.224*	.475**	.620**	.581**	.601**	1	
S	.402**	.374**	.379**	.292**	.264*	.625**	.671**	.575**	.780**	.674**	1
Mean	16.99	16.81	16.69	15.52	19.05	14.33	10.64	14.44	11.06	11.10	15.03
SD	2.733	3.476	2.600	3.432	2.998	2.204	1.701	2.140	1.778	1.922	2.485

$^{**}p < 0.01$; $^{*}p < 0.05$

4.2 Comparing students' perception toward game-like simulation regarding gender

In this study, the data is analyzed for comparing female and male students' perception by MANOVA, as shown in Table 4. It was found that the gender does not significantly effect on perceptions toward the game-like simulation. Also, males or females could learn physics with the game-like simulation.

Table 4: Descriptive and correlation for gender and perception toward game-like simulation

Subscale	Gender	N	Mean	SD	F	Sig.	η^2
Perceived Learning (PL)	Males	32	14.500	2.316	.317	.575	.004
	Females	56	14.232	2.157			
Perceived Ease of Use (PEU)	Males	32	11.167	1.555	4.315	.041*	.049
	Females	56	10.357	1.721			
Perceived	Males	32	14.533	2.177	.000	.988	.000

Subscale	Gender	N	Mean	SD	F	Sig.	η^2
flow (PF)	Females	56	14.939	2.138			
Perceived playfulness (PPF)	Males	32	11.233	1.794	.267	.606	.003
	Females	56	10.964	1.778			
Enjoyment (E)	Males	32	11.533	1.925	1.538	.218	.018
	Females	56	10.875	1.898			
Satisfaction (S)	Males	32	15.433	2.515	.785	.378	.009
	Females	56	14.821	2.465			

$^{*}p < .05$

Table 4 shows the multivariate MANOVA from the impact of gender to perception toward the game-like simulation consists of Perceived Learning (PL), Perceived Ease of Use (PEU), Perceived Flow (PF), Perceived Playfulness (PPF), Enjoyment (E) and Satisfaction (S). It was found that PEU relate to gender. The results from multivariate MANOVA specified that the impact of gender to perception toward the game-like simulation on PL ($F = .317$, partial $\eta^2 = 0.004$), PF ($F = .000$, partial $\eta^2 = 0.000$), PPF ($F = .267$, partial $\eta^2 = 0.003$), E ($F = 1.538$, partial $\eta^2 = 0.018$), and S ($F = 0.785$, partial $\eta^2 = 0.009$). Only one subscale having correlation significant ($p < .05$) is PEU ($F = 4.315$, partial $\eta^2 = 0.049$).

Moreover, Figure 3 shows correlation for genders and perceptions toward the game-like simulation. It was found that all parts of perceptions from males' mean are greater than female, but perceived flow. Overall, males had better perceptions toward the game-like simulation than females. The genders related to Perceived Learning (PL), Perceived Flow (PF), Enjoyment (E) and Satisfaction (S). But genders do not relate to Perceived Ease of Use (PEU). Obviously, males and females perceived that the game-like simulation is easy for using in learning of light concepts.

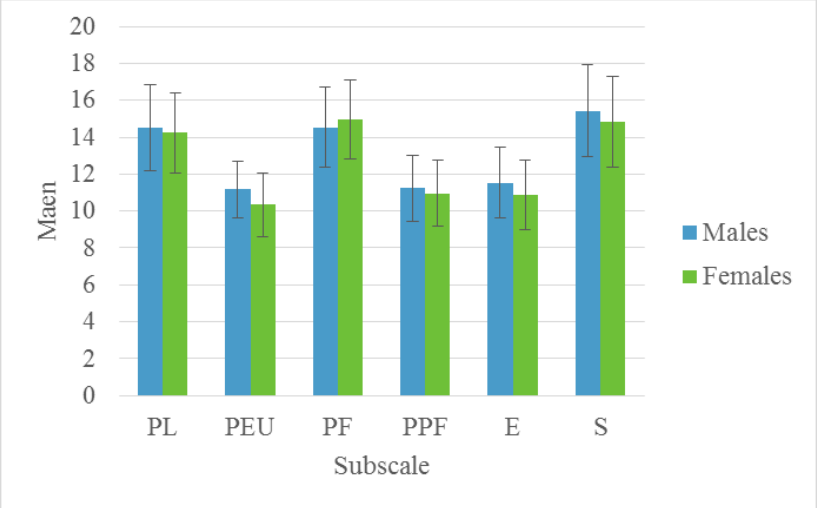

Figure 3. The graph shows that correlation between gender and perception toward game-like simulation

5. Conclusions

This study investigated the impacts of combining digital game with computer simulation named Game-like Simulation on physics motivation and perception. From the previous study indicated

the educational computer game improves perception motivation of student in context of digital game-based learning experience (Meesuk & Srisawasdi, 2014; Nantakaew & Srisawasdi, 2014). The findings revealed that the game-like simulation could improve students' perception and physics motivation. Moreover, it could be used to support learning in Light by females and males. Because the game-like simulation was designed basing on game and computer simulation grounded theory. That is fun, encouraging, challenging, adjusting parameter, and visualizing invisible phenomena. The findings from this study could be used attempt to develop technological tool for supporting learning in Light on physics course.

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