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# Investigating Correlation between Attitude toward Chemistry and Motivation within Educational Digital Game-based learning

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**Abstract:** Educational digital game-based learning, which is one of emerging pedagogies, could promote students' motivation. With the benefit of the educational digital game-based learning, in this study, the educational digital game was designed for learning chemistry. To investigate the effect of attitude toward chemistry lesson on students' motivation when they learn by using educational digital game, the study was conducted on eleventh grade students. The results show that attitude of interest in chemistry lesson makes students understanding and learning chemistry. The importance of chemistry in real-life, chemistry and occupational choice were not related to students' motivation in attention, relevance, confident and satisfaction. Moreover, the students have a positive effect motivation after playing the educational digital game. To this end, this study concludes that the use of educational digital game-based learning could support students' motivation even they have a positive or negative attitude in learning.

**Keywords:** Educational digital game, attitude toward chemistry, motivation

## 1. Introduction

Chemistry, which is the one of most important discipline, explains daily life phenomena. Chemistry concept related to other concepts in science such as the biology, physics and materials science. The nature of chemistry is abstract content which need to use imagination for connecting to real life situation. Chemistry requires three different levels of representation which are macroscopic, submicroscopic, and symbolic level. The topic of adhesive force in chemistry uses three levels of representation for explaining the phenomena. This topic related to understanding the basic phenomena in the science curriculum that student is incomprehensible (Eilam, 2004; Leite, Mendoza and Borsese, 2007).There are many factors related to difficulty in learning chemistry. Sirhan (2007) indicated the main factor of the learning difficulty in chemistry, curriculum content, and overload of students' working memory space, motivation, language and communication. Therefore, motivation and attitude to learn is challenging to study, because they are major factors that effect on the success of learning, achievement and willingness of students. The students do not have motivation to understand if they perceive that those contents are difficult. In other words, format of instruction affects students' attitude toward learning. If teacher could provide student-center instruction, students might be willing to learn.

In contemporary education, proper education needs to focus on students. Instruction based on interests, needs and abilities of students will persuade students willing to learn more, motivate them to learn led to get meaningful learning. Students in digital age interest in implementing technology. So, computer and communication technology, which is used widely today, can involve in education for supporting students' learning. It also provides opportunity for the students to understanding of both basic and in-depth content. Moreover, it may make them to understand the complex process and can apply knowledge into everyday life. Learning by using the educational

digital game-based learning is a model that combines computer technology into the curriculum, so that the students gain both fun and knowledge (McNamara, Jackson and Graesser, 2010). So, the main challenge for educational research is combining digital game and instruction features in chemistry class. San Chee and Tan (2012) designed and develop an educational game named Legends of Alkhimia. They found that the game effectively fosters learning and supports conceptual understanding of chemistry. Moreover, Papastergiou (2009) found that students who learn via the computer game have more motivational than the non-gaming approach. So, educational computer games can be exploited as effective and motivational learning environments. The previous research has indicated that educational digital game in classroom can support learning and increase students' motivation. However, chemistry class in Thailand lack of combining game into the classroom. Before including game with appropriate chemistry instruction, the attitude toward chemistry should be concerned. Therefore, this study investigates correlation between attitude toward chemistry and motivation in learning via playing game.

## 2. Literature Review

### *2.1 Educational Digital Game*

The new media and digital technology industries and digital gaming immerse several environments. 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 employed digital game that insert content of subject matter or information for educational purpose. Several research presented empirical evidences that the educational digital games have positive effect on student learning. It improved not only learning achievement but also learning attitude and motivation to learn (Giannakos, 2013; Pilli and Aksu, 2013; Sung and Hwang, 2013).

### *2.2 Game-based Learning*

In the past, game produce only for entertainment but recently educational researchers have attempted to adapt games for learning which calls educational games or serious game (Sorensen and Meyer 2007; Stone 2008).The games that compose of challenge, control, curiosity and factasy can motivate persistence and enjoyment (Toro-Troconis and Partridge, 2010). The educators have developed games for three goals including: (i) students can learn from playing the game; (ii) the component of game can support learning; and (iii) students have motivation to learn when they learning by playing the game (McNamara, Jackson, & Graesser, 2010). Game-based learning is a kind of constrcutivist-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.

### *2.3 Attitude and Motivation*

The most important students' characteristic associated with successful studies is attitude, motivation, and genuine interest (Berg, 2005). Attitudes and motivation are both important factors for the learning process. Success in learning, positive attitudes to learning and motivation to learn are linked. The two major factors influencing attitudes towards a subject are teacher quality and curriculum quality. They strongly influenced by the perceived curriculum relevance, in the sense that the learner perceives what is taught being related to their lifestyle (Sirhan, 2007). Moreover, Hofstein and Mamlok-Naaman (2011) suggested the three key factors that should be considered for enhancing attitudes and interests are the methods used to present the content, instructional techniques, and gender issues.

## 3. Purpose

The goal of this study was to investigate correlation of attitude toward chemistry with motivation in learning after playing the educational digital game in the topic of adhesive force and to explore students' motivation after providing the game. Specifically, the research questions were answered:

- How were the influences of attitude toward chemistry on the students' motivation after providing the educational digital game?
- Is it suitable to implement the educational digital game in a Thai school?

## 4. Methods

### *4.1 Study Participants*

This study recruited 37 students who are studying in eleventh grade, age ranging from 17 to 18 years in a local public school at the northeastern region of Thailand. They are enrolling program that emphasizes using science and technology in the classroom. They also studied about adhesive force which be contained in the topic of properties of liquid in the last semester.

### *4.2 Instruments*

This research used two instruments for determining students' attitude towards the chemistry lesson and motivation in learning via the game. First, the attitude scale developed from Attitude Towards Chemistry Lesson Scale (ATCLS) of Ayyıldız and Tarhan (2013) consisting of 25 items. All items were classified into four scales, including interest in chemistry lessons (six items), understanding and learning chemistry (ten items), importance of chemistry in real-life (five items), and occupational choice related to chemistry (four items). Its Cronbach's alpha reliability coefficient of this instrument was 0.88, implying that it is reliable. Each scale of ATCLS has Cronbach's alpha reliability coefficient from 0.52 to 0.82. The sample item and description of each scale are provided in Table 1. Second, the motivation in learning via the game investigated by using Instructional materials motivational survey (IMMSS) developed from Huang (2011). This instrument consists of 18 items which are divided into attention (eleven items), relevance (four items), confident (three items) and satisfaction (one item). It Cronbach's alpha reliability coefficient was 0.86.Each scale of ATCLS has Cronbach's alpha reliability coefficient from 0.52 to 0.83.

Table 1: Scale descriptions and sample items for the ATCLS questionnaire.

| Scale | Description | Sample item |
|---|---|---|
| Attention | Extent to which students' response to perceive instructional stimuli provided by the game. | The game has things that stimulated my curiosity. |
| Relevance | Extent to which student connect their prior learning experience with the game. | There were examples that showed me how the game could be important to some people in the learning setting. |
| Confidence | Extent to which student has positive expectation after finishing learning activity. | The game had so much information that it was hard to pick out and remember the important points. |
| Satisfaction | After learning via the game, student accept practice newly acquired knowledge | It felt good to successfully complete the game. |

Table 2 shows the sample item and description for four scales. The answers of students in both ATCLS and MLG scale were labeled as strongly agree (5 point), agree (4 points), partly agree (3 point), disagree (2 point) and strongly disagree (1 point) from the positive to the negative.

Table 2: Scale descriptions and sample items for the IMMSS questionnaire.

| Scale | Description | Sample item |
|---|---|---|
| Interest in chemistry lesson | Extent to which student preferred chemistry learning. | I would like the teaching period of the chemistry lesson more often. |
| Understanding and learning chemistry | Extent to which student developed themselves and implicated in chemistry easily. | I find using chemical symbols to be easy. |
| The importance of chemistry in real life | Extent to which student thought chemistry were appropriate to real-life. | I believe that chemical knowledge helps us interpret seriously events in our daily life. |
| Chemistry and occupational choice | Extent to which student use the information learned in the chemistry classroom for the futuristic work. | My career could be chemist/ chemistry teacher/ chemical engineer. |

### *4.3 Learning Material*

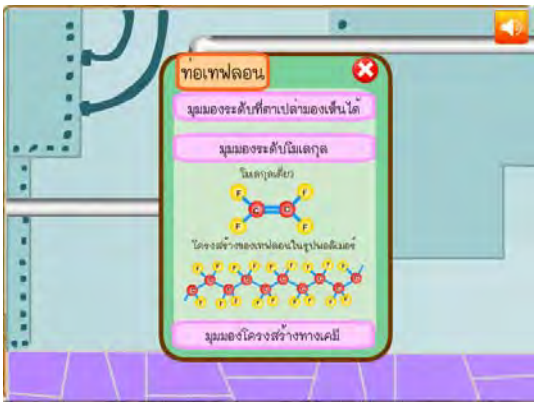
In this study, the design of the game, called "The Pipe", was related to content of adhesive force. The game provides problem situation to students. The game engages students to imagine macroscopic level linked to real life phenomena and also provides information which are three level of representation in chemistry including macroscopic, sub-microscopic and symbolic level. The students were asked to use those information to solve problem. Figure 1 illustrates procedures of learning activity.

### *4.4 Data Collection and Analysis*

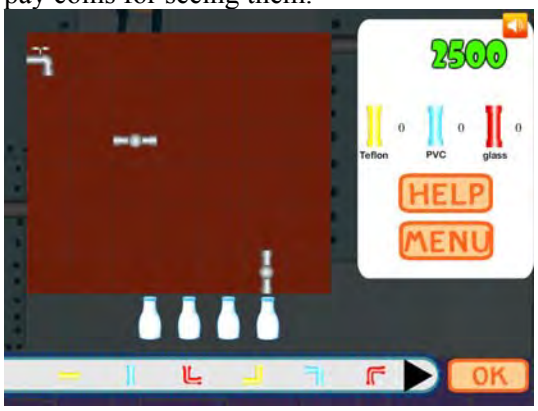
The intervention class consists of 37 students. Before providing The Pipe game, students was surveyed the attitude toward chemistry lesson scale. The Instructional materials motivational survey was provided to the students after they interacted with the developed game. The data from two scales reflected the relation in each variable by using Pearson's correlation in SPSS. The result of Pearson's correlation describe relations of interest in chemistry lesson, understanding and learning chemistry, importance of chemistry in real-life, chemistry and occupational choice in attitude toward chemistry and each scale of motivation including attention, relevance, confident and satisfaction. The influence of attitude toward chemistry on learning motivation via playing the game was investigated.


(A) The game starts with problem situation in the factory. The problem is transferring water through pipes slowly. The player as chemist is asked to choose the proper pipe for the flow of water.

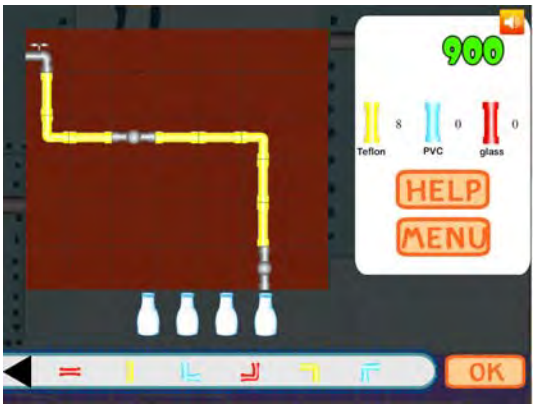

(B) In the game provides scaffolding for decision, the player can see molecular structure of water and each type of pipe. In this part, the player can observe experiment demonstration of the flow of water. However, the player needs to pay coins for seeing them.




(C) This is one sample of the molecules in scaffolding part.




(D) After students click to play a game, it goes in this part in which they pay coins for the various shapes of each pipe for connecting two fix pipes to each other. Students have to concern about budget that they have.




(E) After the player put the proper pipes, they need to click OK bottom for confirming decision.


(F) The last part of the game shows money left, the number of pipes and time used for flowing of water is shown.

Figure 1. Example of chemistry learning activity on properties of liquid.

## 5. Results and Discussion

### *5.1 Correlation between Attitude and Motivation*

Table 3 shows Pearson's correlation of Interest in Chemistry Lesson (ICL), Understanding and Learning Chemistry (ULC), Importance of Chemistry in Real-life(ICR), Chemistry and Occupational Choice (COC) in ATCLS and Attention (A), Relevance (R), Confident (C) and Satisfaction (S) in IMMSS. Mean and standard deviation are also presented in Table 3.

Table 3: Descriptive and correlation for attitude toward chemistry lesson and motivation.

| Scale | ICL | ULC | ICR | COC | A | R | C | S |
|---|---|---|---|---|---|---|---|---|
| ICL | 1 | | | | | | | |
| ULC | 0.57** | 1 | | | | | | |
| ICR | 0.21 | 0.36* | 1 | | | | | |
| COC | 0.66** | 0.563* | 0.61** | 1 | | | | |
| A | 0.13 | 0.10 | 0.19 | 0.16 | 1 | | | |
| R | 0.18 | 0.04 | 0.06 | 0.11 | 0.78** | 1 | | |
| C | 0.16 | 0.21 | 0.11 | 0.13 | 0.64** | 0.61** | 1 | |
| S | 0.14 | 0.05 | 0.02 | -0.06 | 0.67** | 0.57** | 0.74** | 1 |
| Mean | 16.84 | 29.71 | 17.05 | 12.89 | 36.87 | 9.90 | 13.64 | 3.74 |
| SD | 3.19 | 3.178 | 2.86 | 2.70 | 7.11 | 1.81 | 2.60 | 1.03 |

**$p < 0.01$

*$p < 0.05$

Regarding Pearson's correlation analysis of each scale from ATCLS, interest in chemistry lesson was positively related to Understanding and Learning Chemistry (ULC), and chemistry and occupational choice. Understanding and Learning Chemistry (ULC) was positively related to importance of chemistry in real-life (ICR) and chemistry and occupational choice (COC). In addition, importance of chemistry in real-life(ICR) was positively related to chemistry and occupational choice(COC).All scale positively related together except interest in chemistry lesson (ICL) scale that do not relate to importance of chemistry in real-life (ICR). These results imply that students attend to chemistry lesson because they understand chemistry concept and want to work in career related chemistry.

From the result of IMMSS, attention (A), relevance (R), confident (C) and satisfaction (S) are linked together. From the findings, it suggests that if students have only one scale of attention (A), relevance (R), confident (C) and satisfaction (S), they have motivation to learn via games. Consider Table 3, the interest in chemistry lesson (ICL), understanding and learning chemistry (ULC), importance of chemistry in real-life (ICR), chemistry and occupational choice (COC) was no related to attention (A), relevance (R), confident (C) and satisfaction (S) when provided the Pipe game to students. So, the educational digital game can use for all students even if they have a negative or positive attitude toward chemistry.

The findings from previous study revealed that the educational digital game improve both attitude toward learning and motivation, because it furnished more attractive of learning environment (Eseryel, Law, Ifenthaler, Ge and Miller, 2014; Sung and Hwang, 2013). But we do not know about the effect of attitude on motivation during interaction with the educational digital game. This study indicated that motivation in learning via game does not depend on attitude toward chemistry. Although students negative or positive attitude toward chemistry, they can learn chemistry by playing game.

### *5.2 Students' Responses*

The scale of motivation in IMMSS was summarized in Table 4 which shows the means and standard deviation of each scale. We found that students had high level of motivation in attention, relevance, confident and satisfaction after participating in the developed game.

Table 4: Scale means and summary response.

| Scale | Mean (SD) | Description |
|---|---|---|
| Attention | 36.87(7.11) | High level |
| Relevance | 9.90 (1.81) | High level |
| Confident | 13.64 (2.60) | High level |
| Satisfaction | 3.74 (1.03) | High level |

Many previous studies presented that learning via playing game support perspective of cognition and affection. From evidence of achievement test, the game can develop students' performance. Students understand content easily and deeply. For affective domain, the game increase students' motivation. Students preferred to learn by playing game, because they had a positive perspective in learning. They also perceived that the game is useful, easy, interested and enjoyable. All of them can motivate students to learn. We assure that game support learning effectively (Cheng, Huang, and Chen, 2013; Sung and Hwang, 2013).

## 6. Conclusion and implementation

The result of this study provided a more understand on influences of attitude toward subject matter, for example, chemistry, on student's motivation to learn in a setting of educational game learning environment. The finding indicated that attitude toward chemistry have no correlation on motivation to learn chemistry via game. Thus, we can use the educational digital game for participants who have both a positive and negative effect. Although they like or dislike to learn chemistry lesson, they remain have a positive effect after learning via educational digital game.

Although there are many researches indicated that teaching and learning via game improve students' motivation, we should collect pre- and post-motivation for comparing motivation before and after learning. In an addition, the challenge is how to immerse the digital game into classroom instruction. A previous study by San Chee and Tan (2012) used educational game to support students' inquiry learning process, and they found that the students can effectively inquire to learn science through digital game. Based on the findings of this study, we will design educational digital game about properties of liquid use Student-Associated Game-based Inquiry (SAGOI) approach for improving chemistry learning in quasi-experimental design that include two different-intervention groups of students. One group will provide SAGOI instruction and another acquire traditional instruction. The mixed research methodology combined quantitative method of non-equivalent control group design with qualitative method of phenomenological research design will carry out in future research.

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