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# Exploring Elementary School Students' Perceptions toward Simulation-based Mobile Learning based on Predict-Observe-Explain Approach

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**Abstract:** With a mobile device in hands, mobile learning serves to provide new learning opportunities to individuals and it fits with many learning environments, both in classroom setting and in informal learning environments. Recently, researchers have an interest in using mobile technologies and simulations to deliver more effective learning experience to students. This paper presents an exploration of elementary school students' perceptions toward simulation-based mobile learning based on predict-observe-explain (POE) instructional sequence in a physical science lesson of light refraction. A total of ten $4^{th}$ grade students was recruited to participate in this study. They were administered with 21 items of 5-points Likert scale perception questionnaire regarding six perceptual constructs, i.e. perceived learning (PL), perceived ease of use (PEU), flow (FL), perceived usefulness (PU), enjoyment (E), and perceived satisfaction (PS), after interacting with the approach. The result indicated that there was some high degree of positive perceptions toward the approach, and the highest percentage of their perceptions were PU, E, PS, FL, PL, and PEU, respectively. Based on the finding, the simulation-based mobile learning based on POE approach will be redesigned for enhancing students' learning performance in the next study.

**Keywords:** Unobservable, Computer simulation, Mobile phone, POE strategy

## 1. Introduction

Recently, there has been wide interest in applications of mobile technology for teaching and learning. Mobile learning has been defined as learning facilitated by mobile devices such as mobile phones, tablet PCs, and personal media players (Herrington and Herrington, 2007; Valk, Rashid and Elder, 2010). In addition, mobile learning has become widespread as the development of mobile devices with advanced wireless communication technology has encouraged learning "on the move," using mobile devices in educational settings. Following this feature, it allows students to access learning content from various locations and times (Garcia-Cabot, de-Marcos and Garcia-Lopez, 2015; Hyman, Moser and Segala, 2014; Jones, Scanlon and Clough, 2013), and share learning contents with others (Woodill, 2011). As such, the learning with mobile devices could be used to deliver several contents in a manner of anywhere, anytime, and anyone learning.

According to the development of science education in $21^{st}$ century, computers simulations have been recognized worldwide by educators and researchers as pedagogic tool for science teaching and learning. Computer simulations can make unobservable phenomena being visible representation and they could support students' conceptual development and their learning motivation (Srisawasdi et al, 2016). Several researchers indicated that computer animation and simulation can help student in reducing alternative- or misconceptions, and revising and improving conceptual understanding of scientific concepts (Srisawasdi and Kroothkeaw, 2014; Suits and Srisawasdi, 2013). Moreover, Suits and Srisawasdi (2013) mentioned that instructional computer simulation could support students' development of mental model through visualizing scientific phenomena both macroscopic, microscopic, and symbolic levels of chemistry representation. To extend the benefits of simulation for learning, the utilizing of mobile devices for delivering simulation could be an alternative way for engaging students in interacting with real-world modelling on screen. For science learning, mobile learning activities should support the active cognitive engagement of individuals by visualizing dynamic models of real-world components, phenomena, or processes at an unobservable level (Srisawasdi et al., 2016). Moreover, effective teaching strategy should be considered for successful learning and inquiry-oriented predict–observe–explain (POE) procedure is one strategy that could foster and enhance students' cognitive evolution by themselves.

POE learning approach has been recognized by educators and researchers for promoting students' science learning in classroom. The POE procedure was developed at the University of Pittsburgh, and it was used to induce students' conceptual change in science learning for many past decades (Champagne, Klopfer and Anderson, 1980). White and Gunstone (1992) have promoted the predict–observe–explain (POE) procedure as an efficient strategy for eliciting students' ideas and also promoting student discussion about their ideas. The POE procedure is based on the classic model of research where a hypothesis is stated and reasons are given for why this may be true, relevant data is gathered and results are discussed (White, 1988). It involves students predicting the result of a demonstration and discussing the reasons for their predictions; observing the demonstration and finally explaining any discrepancies between their predictions and observations. However, this view is challenge by recent data showing mobile and POE had not address in the use of simulation for mobile learning yet.

Consequently, in this paper, the researchers attempt to design and development simulation-based mobile learning approach with regarding POE sequence. This is a pilot study, which aims to investigate students' perceptions toward the simulation-based mobile learning approach with regarding POE in students learning of light refraction.

## 2. Literature Review

Computer Simulation

Computer simulations represent the real world by using a computer program, and rely heavily on visual representations of the phenomena they model. The simulations can be a valuable tool in today science classroom by exemplifying scientific concepts and situations to students, and allowing students to explore the nature of things. Currently, computer simulations are powerful tools which can make unobservable phenomena being visible representation and they could support students' conceptual learning performance in science. Regarding the use of computer simulations, learners can formulate hypotheses about the simulated environment and test these hypotheses by changing parameters in the simulation and observing the way in which the simulation responds to these changes (Lee, Plass and Homer, 2006). Concurrent with the progressive development in science education community, contemporary technology-based approaches to science learning offers computer simulations with ample opportunities for students' inquiry-related learning environments in science (Srisawasdi and Panjaburee, 2015). Researches indicated that computer simulations can facilitate student reducing alternative conceptions, and improving conceptual understanding of science concepts (Srisawasdi and Kroothkeaw, 2014; Srisawasdi and Sornkhatha, 2014).

Inquiry-based Learning with Predict-Observe-Explain (POE) Strategy

Inquiry-based learning is an important form of learning process in science-based education, as seen from the goals of the national science curriculum in many countries around the world. Currently, inquiry-based learning is one of fundamental pedagogy in science education focused on encouraging students to explore the world through investigative activity. Moreover, the inquiry pedagogy served as the benchmark in Thailand science education for the past decades (Srisawasdi, 2016). By the process of investigation and collection of scientific data, inquiry activities provide a valuable context for learners to acquire, clarify, and apply an understanding of science concepts (Edelson, Gordin and Pea, 1999). Regarding the inquiry-based instructional sequence, Predict-Observe-Explain (POE) strategy is a constructivist-oriented pedagogy that provides an important way to structure students' engagement in learning task, elicit and enhance their understanding of important scientific ideas, and promote discussion of students' science conceptions (Hong et al., 2014). Following the POE strategy, students were assigned to predict the outcome of a demonstration, committing themselves to a possible reason for their prediction, observing the demonstration, and finally explaining any discrepancies between their prediction and observation (Kearney and Treagust, 2001; Kearney, 2004). In the past decades, the POE strategy has been used for eliciting students' understanding (Kearney, 2004), determining students' alternative conceptions (Champagne, Klopher and Anderson, 1980), and promoting conceptual understanding (Tao and Gunstone, 1999). Due to the advancement of learning technologies, researchers reported that the incorporation of POE strategy into digital learning environment affected students' self-efficacy and perceived ease of use in biology learning activity (Nasaro and Srisawasdi, 2014). In addition, Srisawasdi et al. (2016) mentioned that students in the special designed ubiquitous learning outperformed others in development of scientific understanding about sound, and they have better inquiry learning performance. With the support of computer-simulated visualization, Chen et al. (2013) incorporates the POE strategy into a computer simulation learning environment to facilitate the change of alternative conceptions in science and they found that students could correct misconceptions effectively by constructing scenarios that conflict with existing knowledge structures, after interacting with the intervention. Moreover, Monaghan and Clement (1999) implemented collaborative POE activity using computer simulation to foster students' problem solving skills in physics and the results suggested that students used dynamic imagery in mental simulations during the intervention, and the POE strategy can facilitate student's appropriate mental simulations off-line in related physics problems.

## 3. Method

Study Participants

To conduct this pilot study, ten of 4$^{th}$ grade students, aged ranging 9-11 years old, in an elementary school at northeastern region of Thailand were recruited in this study. The participants never have formal science class on the topic of light refraction and any learning experience with computer simulation in science classroom before. This implied that their backgrounds had been heterogeneous before interacting with the simulation-based learning in this study.

Learning Materials and Activity

To implement the simulation-based mobile learning regarding POE approach in this study, a bending light simulation obtained from the Physics Education Technology (PhET) research group was used as an inquiry-supported tool for students. Figure 1 illustrates an example of the PhET bending light simulation used in this study.

Figure 1. Illustrative screens of bending light simulation from Physics Education Technology (PhET): the light travels through the same medium (left) and different mediums (right)

For the learning activity in this study, students were assigned to interact with simulation-based mobile learning regarding POE approach. In the lesson, the students used mobile phone for investigating the refraction of light, as display in Figure 2.

Figure 2. An illustration of the simulation-based inquiry learning activity in classroom: teacher introduced students how to use computer simulation (left) and allowed them to interact individually with computer simulation via mobile phone (right).

The Learning Experience of Simulation-based Inquiry Learning regarding POE approach

In this study, the researchers used mobile devices as a learning tool for simulation-based inquiry learning regarding POE approach. Figure 3 displays a conceptual framework for the simulation-based mobile learning experience.

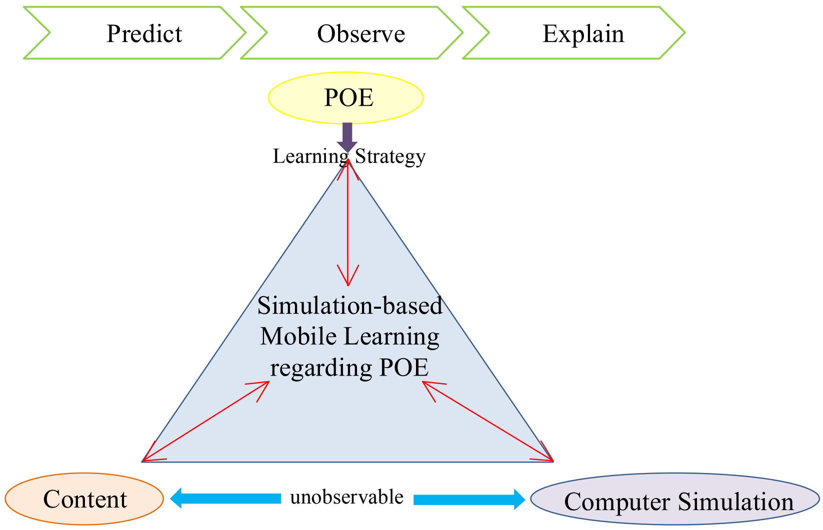
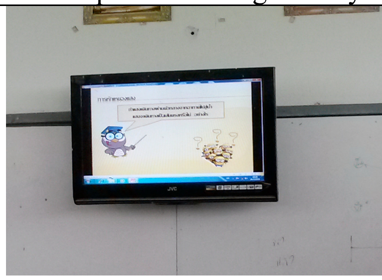
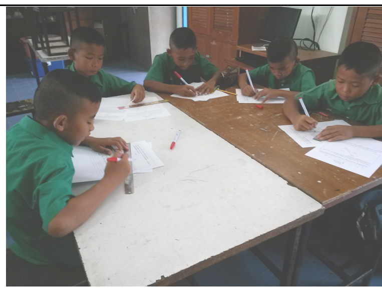
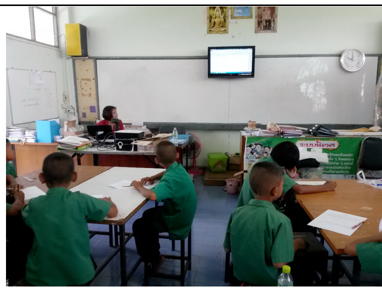



Figure 3. Feature of mobile learning with computer simulation through POE instructional sequence

To promote students' learning with interactive simulation on mobile device, the elementary students took a 2-hours lesson for interacting with the simulation through POE sequence. In this lesson, the teacher began with an introduction of the bending light simulation visualized via a projector. Then, they followed the learning activity as illustrated in Table 1.

Table 1 : An example of simulation-based mobile learning process regarded POE sequence

| Sequence | Description of learning process | Example of learning activity |
|---|---|---|
| Prediction | Teacher provided relevant demonstrations about the phenomena of light refraction. The students were required to give some examples of the light refraction phenomena that happen in daily lives and then to discuss them with the whole class. After, teacher induced students to predict the result of a situation, based on their prior knowledge. |  |
| | Teacher induced students to predict the result of a series of scientific situation, based on their prior knowledge: what would happen when light travel from air to air, air to water, and water to air. Then, they wrote their prediction on a worksheet individually with red ink pen. |  |
| Observation | Teacher instructed students how to use mobile phone for accessing the PhET simulation and also engaged students to interact with the simulation via mobile device by themselves. |  |
| | Teacher allowed students to conduct the light refraction experiments with PhET simulation, and they were assigned to write down evidence obtained from the simulation on their worksheet with blue ink pen. |  |
| Explanation | Teacher engaged student to compare a similarity and/or difference on the prediction and observation. Teacher also engaged them to discuss on the similarity/difference. After, teacher encouraged students to explain another physical phenomenon based on the light refraction concept. |  |

Research Instrument and Data Analysis

In this study, 21-item Likert-scale perception questionnaire (Pinatuwong and Srisawasdi, 2014) has been used for examining students. The questionnaire was used to collect data of perceived learning (4 items), flow (5 items), enjoyment (3 items), perceive ease of use (3 items), perceive of usefulness (3 items), and perceive of satisfaction (3 items). The respondents were assigned to complete the questionnaire after interacting with the simulation-based inquiry learning. In this study, the researchers have analyzed and interpreted the respondents' answers into on each item, respondents were assigned to rate how much the respondent agree with into five scale form 1-strongly disagree to 5-stongly agree. In addition, after the learning activity in classroom, the researcher had interviewed students in order to explore their perceptual aspects of the simulation-based learning. To probe how much students can learn from the learning activity, a POE worksheet was used to measure their conceptual progression along the intervention and their learning performance base on the worksheet were evaluated with the maximum score of 10 points each activity. Figure 4 is an example of students' worksheet illustrated their learning performance.

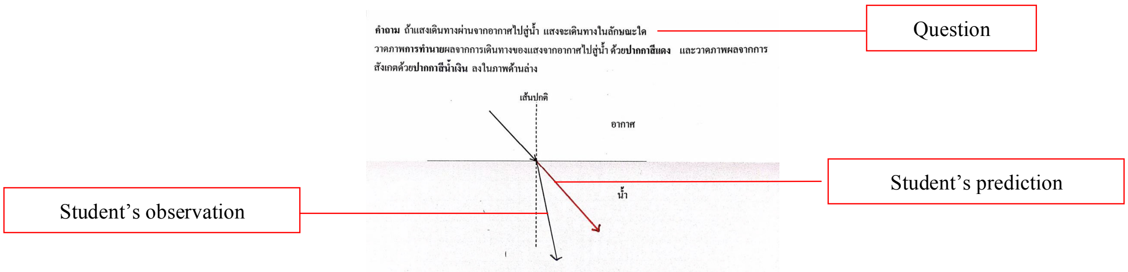



Figure 4. An example of POE worksheet used in this study and student's response

## 4. Result and Discussion

The results of this study is presented in Figure 5. There is the percentage of students' perceptions towards simulation-based mobile learning in science. Figure 5 shows the percentage of their perceptions on perceived learning (PL), flow (FL), enjoyment (E), perceived ease of use (PEU), perceive of usefulness (PU), and perceive of satisfaction (PS).

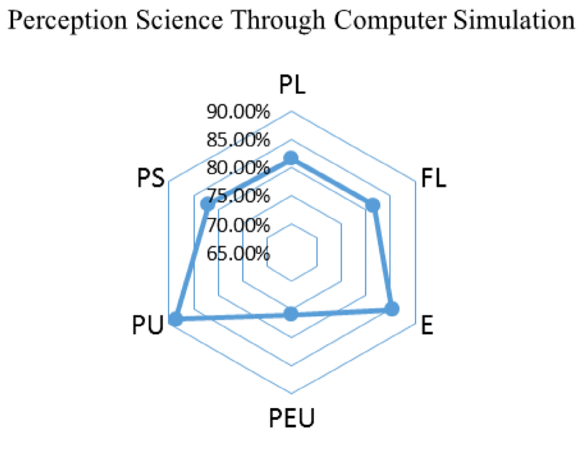



Figure 5. An illustration of elementary school students' perception scores

As seen in Figure 5, the highest score of students' perceptions were perceived usefulness (PU) (88.67%), enjoyment (E) (85.33%), perceived satisfaction (PS) (82.00%), flow (FL) (81.60%), perceived learning (PL) (81.50%), and perceived ease of use (PEU) (76.00%), respectively. The results implied that elementary school students relatively have positive perceptions toward the simulation-based mobile learning on refraction of light. This result is consistent with the research findings that students positively perceived benefits of simulation-based learning and they performed better achievements with learning from computer simulation (Buyai and Srisawasdi, 2014; Kaeosueptrakul and Srisawasdi, 2015; Pinatuwong and Srisawasdi, 2014; Udomrat and Srisawasdi, 2015).

## 5. Further Study

According to the result of this study, the researchers have a plan to conduct a further study for investigating elementary school students' conceptual understanding, scientific explanation performance, and their science motivation. In the next study, the POE sequence was implemented in a series for probing and fostering students' conceptual understanding about light refraction and for increasing the students' motivations to learn science by participating in the simulation-based mobile learning process. Particularly, the reconciling of any conflict between their predictions and observations was focused as the key for probing the students' scientific understanding of light refraction through the POE learning activities. The design of the simulation-based mobile learning activities through POE strategy consisted of four learning targets and a weekly learning target, including reflection of light, refraction of light, spectrum of light, and the visible light. A brief explanation of a series of POE-based mobile inquiry learning activities is displayed in Figure 6.

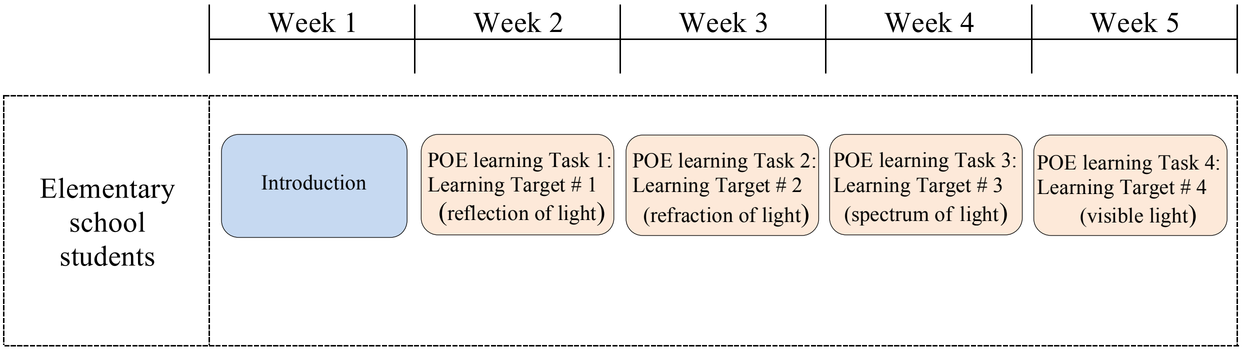



Figure 6. A series of POE-based mobile learning with computer simulation for the next study

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## References

Buyai, J., & Srisawasdi, N. (2014). An investigation of relationships between biology attitudes and perceptions toward instructional technology in analogy-based simulation on light reaction. In Liu, C. C. et al. (Eds.). *Proceedings of the 22nd International Conference on Computers in Education. Japan: Asia-Pacific Society for Computers in Education.* Nara: ICCE 2014 Organizing Committee, Japan

Champagne, A., Klopfer, L., & Anderson, J. (1980). Factors influencing the learning of classical mechanics. *American Journal of Physics, 48*(12), 1074-1079.

Chen, Y. L., Pan, P. R., Sung, Y. T., & Chang, K. E. (2013). Correcting misconceptions on electronics: Effects of a simulation-based learning environment backed by a conceptual change model. *Educational Technology & Society, 16*(2), 212-227.

Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *Journal of the Learning Sciences, 8*(3/4), 391-450.

Garcia-Cabot, A., de-Marcos, L., & Garcia-Lopez, E. (2015). An empirical study on m-learning adaptation: Learning performance and learning contexts. *Computers & Education*, *82,* 450-459.

Herrington, A., & Herrington, J. (2007). Authentic mobile learning in higher education. *In proceedings of AARE International Educational Research Conference*, Fremantle: Western Australia.

Hyman, J. A., Moser, M. T., & Segala, L. N. (2014). Electronic reading and digital library technologies: Understanding learner expectation and usage intent for mobile learning. *Educational Technology Research and Development, 62*(1), 35-52.

Hung, P. H., Hwang, G. J., Lee, Y. H., Wu, T. H., Vogel, B., Milrad, M., & Johansson, E. (2014). A problem-based ubiquitous learning approach to improving the questioning abilities of elementary school students. *Education Technology & Society, 17*(4), 316-334.

Jones, A. C., Scanlon, E., & Clough, G. (2013). Mobile learning: Two case studies of supporting inquiry learning in informal and semiformal settings. *Computers & Education, 61*, 21-32.

Kaeosueptrakul, W., & Srisawasdi, N. (2015). Motivation is important when they learn chemical equilibrium with computer-simulated experimentation: A pilot study. In Liu, C.-C. et al. (Eds.), *Proceedings of the 23nd International Conference on Computers in Education* (pp. 511-518), Nara, Japan: Asia-Pacific Society for Computers in Education.

Kearney, M., & Treagust, D. F. (2001). Constructivism as a referent in the design and development of a computer program which uses interactive digital video to enhance learning in physics. *Australian Journal of Educational Technology*, *17*(1), 64-79.

Kongpet, K. & Srisawasdi, N. (2015). Combining context-aware ubiquitous learning and computer simulation: A lesson learned in elementary science education. In Liu, C.-C. et al. (Eds.), *Proceedings of the 23nd International Conference on Computers in Education* (pp. 236-243), Nara, Japan: Asia-Pacific Society for Computers in Education.

Lee, H., Plass, J. L., & Homer, B. D. (2006). Optimizing cognitive load for learning from computer-based science simulations. *Journal of Educational Psychology, 98*(4), 902-913.

Lin, C.-C. Chen, F.-J & Liu, C.-C. (2014). Applying POE framework in a simulation system for facilitating physics learning with Tablet PCs. In Liu, C.-C. et al. (Eds.), *Proceedings of the 22nd International Conference on Computers in Education* (pp. 551-553), Nara, Japan: Asia-Pacific Society for Computers in Education.

Monaghan, J. & Celement, J. (1999). Use of a computer simulation to develop mental simulations for understanding relative motion concepts. *International Journal of Science Education, 21*(9), 921-944.

Rutten, N., Van, W. R., & Van, J. T. (2012). The learning effects of computer simulations in science education. *Computer & Education*, *58*, 136-153.

Nasaro, C., & Srisawasdi, N. (2014). Students' self-efficacy and acceptance toward context-aware ubiquitous learning in biology education: A case of photosynthesis in plant. *Proceedings of the 22nd International Conference on Computers in Education* (pp. 413-420), Nara, Japan: Asia-Pacific Society for Computers in Education.

Pinatuwong, S. & Srisawasdi, N. (2014). An investigation of relationships between biology attitudes and perceptions toward instructional technology in analogy-based simulation on light reaction. In Liu, C.-C. et al. (Eds.), *Proceedings of the 22nd International Conference on Computers in Education* (pp. 149-152), Nara, Japan: Asia-Pacific Society for Computers in Education.

Ruttanasaeng, S. & Srisawasdi, N. (2015). An exploration of relationship between motivation and perceptions in physics learning of light through game-like simulation and its impact on the gender gap. In Liu, C.-C. et al. (Eds.), *Proceedings of the 23nd International Conference on Computers in Education* (pp. 160-168), Nara, Japan: Asia-Pacific Society for Computers in Education.

Srisawasdi, N. (2015). Motivating inquiry-based learning through a combination of physical and virtual computer-based laboratory experiments in high school science. In M. Urban, & D. Falvo (Eds.) *Improving K-12 STEM Education Outcomes through Technological Integration (pp. 108-134).* Hershey, PA: IGI Global. doi:10.4018/978-1-4666-9616-7.ch006.

Srisawasdi, N., Kongpet, K., Muensechai, K., Feungchan, W., & Panjaburee, P. (2016). The study on integrating visualized simulation into context-aware ubiquitous learning activities for elementary science education. *International Journal of Mobile Learning and Organization, 10*(4), 263-291.

Srisawasdi, N. & Kroothkeaw, S. (2014). Supporting students' conceptual development of light refraction by simulation-based open inquiry with dual-situated learning model. *Computers in Education Journal, 1*(1), 49-79.

Srisawasdi, N., & Panjaburee, P. (2015). Exploring effectiveness of simulation-based inquiry learning in science with integration of formative assessment. *Journal of Computers in Education, 2*(3), 323-352.

Srisawasdi, N., & Sornkhatha, P. (2014). The effect of simulation-based inquiry on students' conceptual learning and its potential applications in mobile learning. *International Journal of Mobile Learning and Organisation, 8*(1), 24-49.

Suits, J. P. & Srisawasdi, N. (2013). Use of an interactive computer-simulated experiment to enhance students' mental models of hydrogen bonding phenomena. In J.P. Suits & M.J. Sanger (Eds.) *Pedagogic roles of animations and simulations in chemistry courses,* ACS Symposium Series 1142, American Chemical Society: Washington, DC.

Tao, P., & Gunstone, R. (1999). The process of conceptual change in force and motion during computer-supported physics instruction. *Journal of Research in Science Teaching, 36*(7), 859-882.

Tao, Y.-H., Cheng, C.-J., & Sun, S.-Y. (2009). What influences college student to continue using business simulation games? The Taiwan experience. *Computer & Education*, *53*, 929-939.

Udomrat, C. & Srisawasdi, N. (2015). Evaluation of secondary school students' perceptions toward combination of digital learning technology for physics learning. In Liu, C.-C. et al. (Eds.), *Proceedings of the 23nd*

*International Conference on Computers in Education* (pp. 252-258), Nara, Japan: Asia-Pacific Society for Computers in Education.
Valk, J. H., Rashid, A. T., & Elder, L. (2010). Using mobile phones to improve educational outcomes: An analysis of evidence from Asia. *International Review of Research in Open & Distance Learning*, *11*(1), 117-140.
White, R. (1988). *Learning science*. Oxford, UK: Basil Blackwell.
White, R., & Gunstone, R. (1992). *Probing understanding.* London and New York: The Falmer Press.
Woodill, G. (2011). The mobile learning edge: Tools and technologies for developing your teams. New York: *McGraw-Hill Professional*.