Chen, W. et al. (Eds.) (2016). Workshop Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education

Exploring Preservice Teachers' Perception of Simulation-based Learning in Physics Education: A Preliminary Study of Lao People's Democratic Republic

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Abstract: With the importance of understanding physics concepts of sound wave and learning physics perception and of preservice teacher education in preparing student teachers before they have undertaken teaching the concept, it would be better to know the status of their conceptual understanding of the topic and their learning physics perception. Consequently, there are two phases in this study as follows: (1) investing understanding of the topic and perception after learning in the conventional learning activities by using conceptual understanding test and questionnaire, respectively; and (2) exploring understanding of the topic during learning in the proposed computer simulation-based inquiry learning and the perception toward the proposed learning. The results from the 3rd year student teachers from Teachers College in Dongkhamxang, Lao PDR, showed that most of the preservice physics teachers held misunderstanding of sound, such as reflection, refraction, interference, and speed of sound in the different mediums and temperature. Moreover, all of them held misunderstanding of sound diffraction concept. Interestingly, after finishing in the proposed computer simulation-based inquiry learning, they reflected that the highest score relied on enjoyment, perceived of usefulness, perceived learning, perceived satisfaction, perceived ease of use, and flow, respectively. It leads to rethinking of pedagogy used for teaching physics of sound wave in order to improving the preservice physics teachers' conceptual understanding and fostering their perception in Laos.

Keywords: Teacher education, preservice, perception, physics education, sound wave.

1. Introduction

In the past decade, several researchers revealed that many students had difficulty in learning science course due to their misconceptions in several science contents, especially properties of sound wave (Pirakra and Srisawasdi, 2014; Singh, Singh, Kumari and Kumar, 2011; Lee, Hairston, Thames, Lawrence and Herron, 2002). By the nature of content, the properties of sound wave involve reflection, interference, reflection, diffraction, and propagation of sound wave. Meanwhile, sound wave interference is invisible, complicated, and boring content (Piraksa and Srisawasdi, 2014). Transforming ideas and correcting defects of students' knowledge in physics is beyond the reach of the traditional teaching approaches. Because they tend to ignore the possibility that the perception of students is possibly different much than that of the teacher (Jimoyiannis and Komis, 2001). Computer simulation, therefore, serves as an educational tool for science learning activities, especially, in activity-based scientific inquiry and in conceptual development in physics sound wave (Srisawasdi and Kroothkeaw, 2014).

In learning physics, there are several scientific activities, which cannot be conducted using real laboratory experiments in a classroom setting. Because the experiment is either impossible to conduct, too dangerous, too complex or take too long. In contrast, where there is limited classroom time, computer simulation plays an important role in the physics classroom by providing students opportunity to study different kinds of scientific phenomena in a variety of circumstances (Srisawasdi and Kroothkeaw, 2014; Jimoyiannis and Komis, 2001; La Velle, McFarlane and Brawn, 2003). More importantly, the computer simulations offer an easy way of controlling experimental variables, opening up the possibility of exploration and hypothesizing. An additional advantage of simulations is presenting a variety of representational formats including diagrams, graphics, animations, sound and video that can facilitate understanding (Blake and Scanlon, 2007). Normally, teachers' teaching in a regular classroom can encourage students to succeed in school and unable to motivation to learn as interact in complex ways to lead learning (Schunk, 2005). Several researchers revealed that such teaching approach might depress motivation of students and decrease students' learning performance science (Hamzah and Mdzain, 2010). Recently, although, most researchers have been concentrated on the scientific conceptions. However, the issues of motivation to learn science has been becoming in respect of science achievement and scientific conceptions (Glynn et al., 2011). It is difficult to achieve this ultimate goal because many learners are treated with less motivation to learn science (Pirakra and Srisawasdi, 2014). In the meantime, the teaching of physics student teachers in Laos has been not currently satisfied to potential learning. The teaching method most provides the textbook by taking the form of lectures; the student teachers just read notes of explanation, memorization, and do exercises based on the teacher as narrator.

As mentioned above, the concept of sound wave is a basic and yet important one in physics education. The student teachers are need to prepare acquiring the scientific concept properly in order to understand the advanced concepts in the future. Possible misunderstanding about sound wave, therefore, must be identified and remedied (Srisawasdi and Kroothkeaw, 2014). The computer simulation might provide them opportunity to visualize the refraction of light when it passes from a fast medium to a slow medium, bending the light rays toward the boundary between the two medium, in order to confront their misunderstanding. However, computer simulation alone was not enough to promote students' understanding (Srisawasdi, 2012). It is needed to incorporate with an effective learning process. Consequently, this study has proposed simulation-based inquiry for learning sound wave of physics. In this vein, this paper aims to separate into two folds as follows: (1) investigating the status of understanding of the topic and perception toward the conventional teaching method; and (2) exploring understanding of the topic during learning in the proposed teaching method and perception toward the method.

2. Relevant Research

According to the rapid growth of computers and technologies in the practice and progression of physics education community, computer simulation offers students to learning physics through inquiry-based process (Rutten, 2012; Srisawasdi and Panjaburee, 2015; Vreman-de Olde, 2013; Kaeosueptrakul and Srisawasdi, 2015). Simulation is a computer-based visualization technology, which can imitate dynamic systems of objects in a real supporting to the quality of making sense by vision. Computer simulation has been used extensively as a visual representation tool to simplify dynamic theoretical models of real world phenomena or processes. It works with remedial by producing change to student's misconceptions (Bell, and Trundle, 2008). Computer simulation also improves scientific process skills and the performance of gaining more qualitative knowledge more coherent understanding of the concepts and more advanced mental model. Conclusively, the computer simulation is mentioned widely that it could be used to facilitate the construction of mental model and the development of conceptual understanding (Suits and Srisawasdi, 2013).

To address conceptual learning problems in physics outlined in the previous section, the simulation-based inquiry learning has been becoming a pedagogical approach for enhancing students' conceptual learning and development in school science (Srisawasdi and Kroothkeaw 2014; Srisawasdi and Sornkhatha, 2014). Researchers found that simulation-based inquiry learning worked with remedial by producing change to the alternative conceptions held by learners, improving the performance of gaining intuitive domain knowledge, promoting more qualitative knowledge than formalized knowledge, and achieving a more theoretical focus and coherent understanding of the concepts (Srisawasdi and Panjaburee, 2015).

3. Methods

Participants

The 3rd year student teachers from Teachers College in Dongkhamxang, Lao People's Democratic Republic were recruited to participate in this study. There were two phases of this study. The first and the second phase were conducted in the first semester and in the second semester, respectively, in 2015 academic year. There were 33 and 30 student teachers participating in the first phase and the second phase, respectively. In the first phase, the student teachers participated in the conventional learning activities of the sound wave topic. After that, they were asked to take a conceptual understanding physics of sound wave test in 20 minutes followed by the motivation questionnaire about physics learning. While, in the second phase, the student teachers participated in the proposed simulation-based inquiry learning. During learning, they were asked to reflect their understanding of the topic in the activity sheet. After fishing the learning activities, they were asked to response the perception questionnaire toward the simulation-based inquiry learning.

Research Instruments

In this study, there are two research instruments as measuring tools of conceptual understanding and perception. The first tool is a conceptual test involving conception of physics learning in pitch of sound wave. The test is designed basing on the four-choice question to measure the ability of understanding on the topic. Totally, it consists of 12 test items covering the concepts of pitch of sound wave. Each question requires the student teachers to clarify and provide the reasons for their understanding. The second tool is a questionnaire. It is 5-points Likert-scale questionnaire to investigate the student teachers' perception. Totally, it consists of 21 items covering Perceived learning (PL) (4 items), Flow (EL) (5 items), Enjoyment (E) (3 items), Perceived ease of use (PEU) (3 items), Perceived usefulness (PU) (3 items), and Perceived satisfaction (PS) (3 items) aspects. The questionnaire was obtained from Chang's (2014) and Barzilai and Blau's (2004) studies. We translated the questionnaire from English version to an identical version in Thai; one expert was recruited to identify communication validity of the items. The student teachers were required to consider each possible reason for simulation-based inquiry learning how much they agree with into five scale (1-strongly disagree; 2-disagree; 3-neutral; 4-agree; 5- strongly agree). The reliability for the overall questionnaire was 0.88.

The Design of Simulation-based Inquiry Learning for Sound Wave

With the benefits of computer simulation in being able to promote learning science and motivate the student teachers in phenomena having dynamic visual and abstract as the sound wave. The student teachers cannot see that the way of sound wave, which is difficult to understand. The computer simulation could be used to solve this issue. Moreover, the inquiry-based learning approach could be served as teaching method. It could provide student teachers strategy to make science accessible by empirical evidence that is observable phenomena. The students are asked to further conducting an investigation of unobservable phenomena. When they gain knowledge by related concepts, they are asked to link three explanations together and result in knowledge construction for becoming the conceptual understanding, as shown in Figure 1.

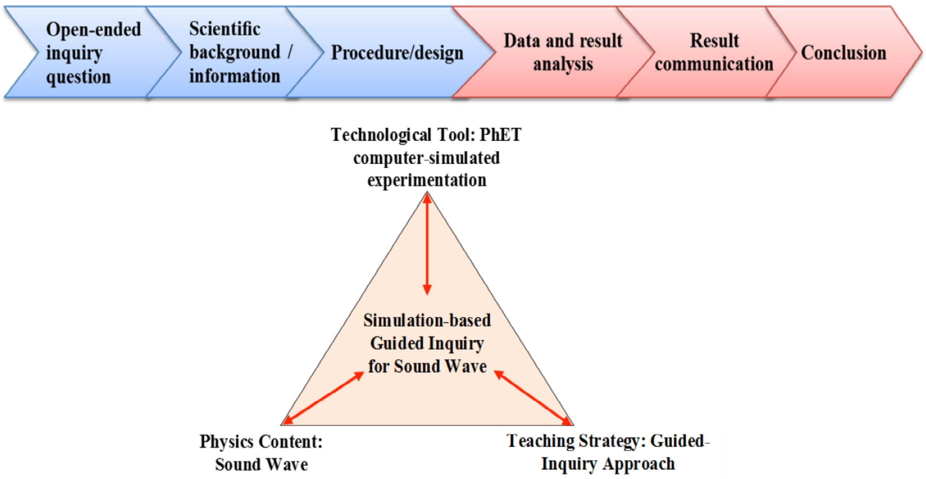

Figure 1. Computer Simulation-based Inquiry

According to Buck, Bretz and Towns (2008)'s idea, the learning process of inquiry-based physics learning with computer simulation could possibly be proposed in a combination of inquiry components and computer-based inquiry activities, in order to creating a unique learning environments of inquiry learning with computer simulation technology in this study as depicted in Table 1.

Table 1: Components of simulation-based inquiry for sound wave

Components of simulation-based guided-inquiry learning		Description of learning process	Example of learning activity
Pre-lab	Open-ended inquiry question	Teachers brought into the lesson by asking students how sound wave caused by anything.	
	Information	The teacher explained the process conducted by the computer simulation of the sound wave.	
Laboratory	Procedure/design	Students design their own scientific experiments and then interact with sound simulation for collecting the experimental data.	
	Data and result analysis	Students group analyzed data gathered in groups to create their own conclusions from the data.	

Components of simulation-based guided-inquiry learning		Description of learning process	Example of learning activity
Post-lab	Result communication	Student representatives of each group to present findings to the class.	
	Conclusion	Students share the results of experiments using computer simulations.	

4. Results

4.1 Phase 1: Results of Understanding and Motivation to Learn in Conventional Teaching Method

This phase was conducted in the first semester in 2015 academic year. There were 33 student teachers participating in this phase. The student teachers participated in the conventional learning activities (lecture with reading, writing, and memorizing) of the sound wave topic. After that, they were measured whether they had understanding or misunderstanding of sound wave by using the conceptual test, followed by the motivation questionnaire about physics learning. The results of conceptual understanding and motivation to learning physics were shown as following sections.

4.1.1 Conceptual Understanding of Sound Wave

The results from the conceptual test covering six concepts of sound wave including Reflection, Diffraction, Refraction, Interference, Speed of sound in the different medium, and Speed of sound at the different temperature show that all of the student teachers had misunderstanding of the Diffraction concept (100%). Most of them had scientific understanding of Speed of sound at the different temperatures concept (31.82%), as shown in Table 2 and Figure 2.

Table 2: Percentage of the student teachers' conceptual understanding scores of sound wave

Concept	Scientific understanding	Misunderstanding
C1: Reflection	13.64%	86.36%
C2: Diffraction	0%	100%
C3: Refraction	9.09%	90.91%
C4: Interference	15.15%	84.85%
C5: Speed of sound in the different medium	6.06%	93.94%
C6: Speed of sound at the different temperatures	31.82%	68.18%

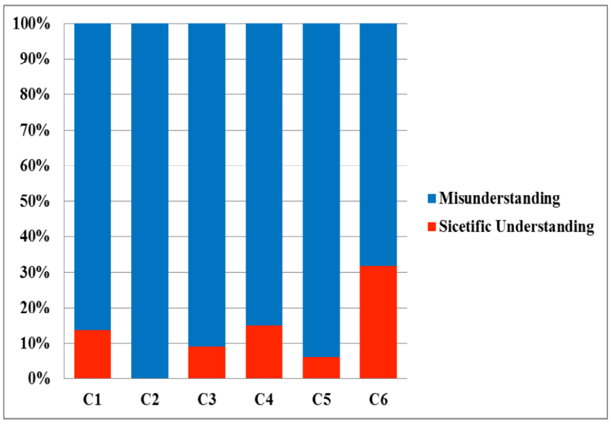

Figure 2. An illustration of percentage of student teachers' conceptual understanding scores of sound wave

4.1.2 Physics Motivation

When analyzing the motivation to learn physics, we found that the student teachers were motivated to learn physics at low levels in Intrinsic Motivation, Career Motivation, Self-efficacy, Self-determination, and Grade Motivation as shown in Table 3 and Figure 3. It implies that the teaching and learning based on the teacher-centered could not motivate the student teachers to learning physics course.

Table 3: Percentage of the student teachers' physics motivation scores

Motivation toward physics learning	Average
Intrinsic Motivation (IM)	20.06
Career Motivation (CM)	19.55
Self-efficacy (SEC)	17.03
Self-determination (SDT)	14.88
Grade Motivation (GM)	18.06

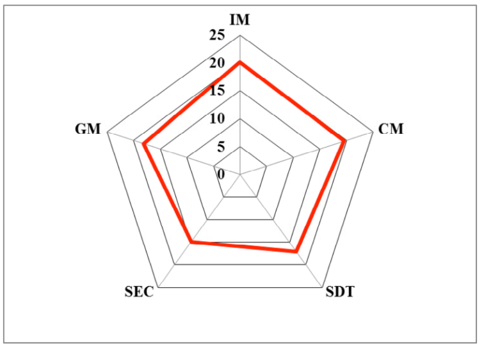

Figure 3. An illustration of the student teachers' physics motivation scores

4.2 Phase 2: Results of Understanding and Motivation to Learn in Simulation-based Inquiry Learning

This phase was conducted in the second semester in 2015 academic year. There were 30 student teachers participating in this phase. The student teachers participated in the simulation-based inquiry of the sound wave topic. After that, they were asked to reflect concept of sound wave by using the activity sheet during participating in the simulation-based inquiry, followed by the motivation questionnaire about the learning. The results of conceptual understanding and motivation to learning physics were shown as following sections.

4.2.1 Conceptual Understanding of sound wave during the computer simulation

For exploring student teachers' understanding about sound wave through the computer simulation, six of them were asked to draw a picture concerning wave. We found that 76.11% of them could draw pictures of waves during learning with the simulation-based inquiry learning as shown in Figure 4.

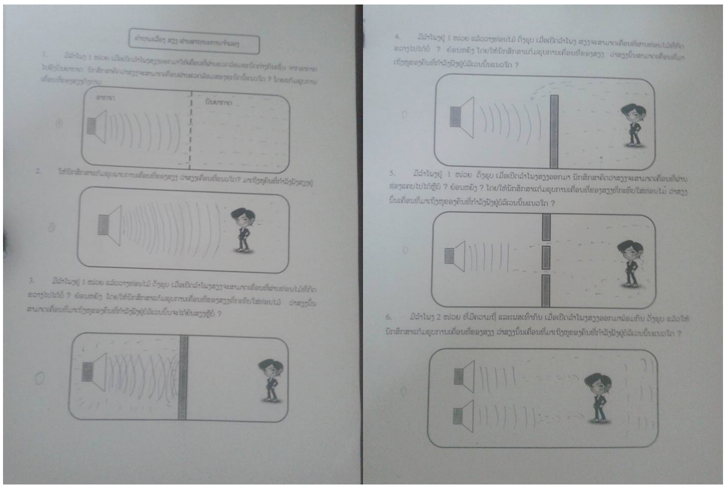

Figure 4. An example of student teachers' conceptual understanding of sound wave

4.2.2 Perceptions towards learning science through the simulation-based inquiry learning

Table 4 and Figure 5 shows that the student teachers reflected the highest score on Enjoyment, Perceived of usefulness, Perceived learning, Perceived satisfaction, Perceived ease of use, and Flow, respectively.

Table 4: Percentage of the student teachers' perception scores

Dimension	Sample items	Percentage
Perceived learning (PL)	- The simulation added to my knowledge. - I learned new things from the simulation. - The simulation will help me remember the things I learned. - I have learned so much from the simulation on a computer. -	85.17%
Flow (FL)	- I lost track of time when I played. - I really got into the simulation. - Playing the simulation was pleasant. - I fully concentrated on learning science through hands on computer simulation. - Learn through scientific scenarios on the computer. I cannot think of anything else that is not related at all.	82.93%
Enjoyment (E)	- I enjoyed the simulation. - I had fun playing the game. - Playing the simulation was pleasant. -	89.33%
Perceived ease of use (PEU)	- It is easy for me to learn how to use simulation. - The user interface of simulation is easy to use. - I can easily accomplish what I need to do in simulation. -	84.22%

Dimension	Sample items	Percentage
Perceived of usefulness (PU)	- Simulation can help me learn more effectively. - Simulation can improve my course performance. - It is useful to study the course content with simulation. -	87.33%
Perceived satisfaction (PS)	- I feel comfortable to use simulation. - I enjoy the experience of using simulation. - I am willing to continue using simulation for learning in other courses.	84.89%

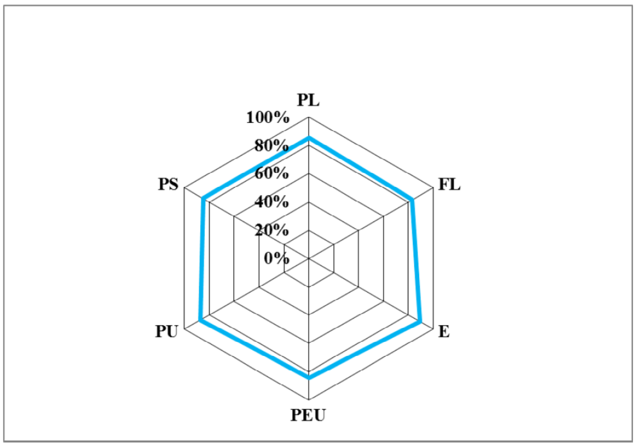

Figure 5. An illustration of the student teachers' perception scores

5. Conclusion and Future Work

The results from two phases in this study clearly revealed that the conventional teaching method, such as lecture with reading, writing, and memorizing of the sound wave topic, led student teachers held misconception of the topic and less motivation to learning the topic. Interestingly, the proposed simulation-based inquiry learning, such as using open-ended questioning, providing science basic knowledge about sound wave, asking them to inquire sound wave phenomena from the computer simulation, collecting evidence from the phenomena, discussing the evidence, and constructing their own knowledge, could promote their conceptual understanding reflected by drawing of the wave in the activity sheet. Moreover, the student teachers shoed positive perceptions toward the simulation-based inquiry learning. Because this learning environment provide student teachers opportunity to visualize the sound wave phenomenon and to help them view properties of sound wave and speed of sound wave concepts. These finding lead us to carefully rethinking of planning using the computer simulation with an effective pedagogy as inquiry-based learning in Laos's classroom of physics for preservice teachers. The success of further implementation plays an important role in enhancing preservice teachers understanding physics concepts and encouraging them to learn.

Acknowledgements

This research project is supported by Thailand International Cooperation and Development Agency (TICA) scholarship and Thanks to the Teachers College in Dongkhamxang, Lao PDR in cooperation of data collection. In addition, this research was financial supported by Graduate School, Khon Kaen University, Thailand.

References

Blake, C., & Scanlon, E. (2007). Reconsidering simulations in science education at a distance: features of effective use. *Journal of Computer Assisted Learning, 23*(6), 491-502.

Bell, R. L., & Trundle, K. C. (2008). The use of a computer simulation to promote scientific conceptions of moon phases. *Journal of Research in Science Teaching, 45*(3), 346-372.

Kroothkaew, S. & Srisawasdi, N. (2013). Teaching how light can be refracted using simulation-based inquiry with a dual-situated learning model. *Procedia – Social and Behavioral Sciences, 93*, 2023-2027.

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.

Piraksa, C., & Srisawasdi, N. (2014). Promoting students' physics motivation by blended combination of physical and virtual laboratory environment: A result on different levels of inquiry. In *Proceedings of the 22nd International Conference on Computers in Education* (pp. 340-348), Nara, Japan: Asia-Pacific Society for Computers in Education.

Lee, A. T., Hairston, R.V., Thames, R., Lawrence, T., & Herron, S. S. (2002). Using a computer simulation to teach science process skills to college biology and elementary education majors. *Bioscience, 28*(4), 35-42.

La Velle, L., McFarlane, A., & Brawn, R. (2003). Knowledge transformation through ICT in science education: A case study in teacher-driven curriculum development - case study 1. *British Journal of Educational Technology, 34*(2), 183-199.

Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & Education, 58*(1), 136-153.

Singh, M. K., Singh, S., Kumari, A., & Kumar, P. (2011). Teach biology science using a computer simulation process. *International Transactions in Applied Sciences, 4*(2), 267-270.

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

Srisawasdi, N. (2012). Student teachers' perceptions of computerized laboratory practice for science teaching: A comparative analysis". *Procedia – Social and Behavioral Sciences*, *46*, 4031-4038.

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* (pp. 241-271). ACS Symposium Series 1142, American Chemical Society: Washington, DC.

She, H. C. (2003). DSLM instructional approach to conceptual change involving thermal expansion. *Research in science and Technological Education, 21(1),43-45.*

She, H. C. (2004). Fostering radical conceptual change through dual-situated learning model. *Journal of Research in Science Teaching, 41(2), 142-164.*

Schunk, D. H. (2005). Self-regulated learning: The educational legacy of Paul r. Pintrich. *Educational Psychologist, 40*, 85-94.

Hamzah, M. S., & Mdzain, A. N. (2010). The effect of cooperative learning with DSLM on conceptual understanding and scientific reasoning among form four physics students with different motivation levels. *Bulgarian Journal of Science and Education Policy, 4*(2), 275-309.

Vreman-de, c., de Jong, T., & Gijlers, H. (2013). Learning by designing instruction in the context of simulation-based inquiry learning. *Educational Technology and Society*, *16*(4), 47-58.