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มหาวิทยาลัยราชภัฏยะลา

รายงานสืบเนื่องจากงานประชุมวิชาการระดับชาติด้านวิทยาศาสตร์และเทคโนโลยีเครือข่ายภาคใต้ ครั้งที่ 8 และ
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จัดพิมพ์แบบ อิเล็กทรอนิกส์

The Development Scientific Concepts of Science Student Teachers using POE Teaching Method Combined with Tracker Program

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Abstract

The objectives of this research were 1) to investigate conceptual understandings of science student teachers in wave-particle duality topic, 2) to study the learning achievement of science student teachers, and 3) to study science student teachers' satisfaction towards the predict-observe-explain (POE) teaching method combined with the tracker program. The samples were 30 science student teachers from Yala Rajabhat University in Thailand. Research tools were two-tier multiple-choice questions, learning achievement tests, and a questionnaire on satisfaction. The collecting data provided science student teachers to do a pretest before they studied with the POE teaching method combined with the tracker program. Two-tier multiple-choice questions, posttest and the satisfaction questionnaire test was given to science student teachers to do after learning. The results found that science student teachers had a complete understanding (CU) of the wave-particle duality content at 53.33% and some of them were a partial understanding (PU) of the wave-particle duality content at 70.00%. The learning achievement showed that most of them improved their score after studying by POE teaching method combined with the tracker program which is significantly higher than before learning at .05 level. The satisfaction of science student teachers towards the POE teaching method combined with the tracker program was at satisfied level.

Keywords: Scientific concepts, Predict-observe-explain (POE) teaching method, Tracker program, Learning achievement.

Introduction

In the current, learning skills in the 21st century plays an important role in science learning such as critical thinking, problem solving, and creative thinking. Students need to know about skills of learning in the 21st century and science processes in order to apply them in everyday life. Scientific knowledge is the foundation of knowledge used to explain natural phenomena student can decisions using scientific knowledge-based ways of thinking. In addition, understanding scientific concepts are fundamental in which a person explains and predicts natural phenomena. Therefore, science teaching and learning management must focus on processes to prompt students to think and learn by themselves through observation surveys as well as laboratory experiments. Furthermore, learning science while participating in group activities in class can solve problems using scientific methods. Students can sophisticate thought processes and comprehension of scientific concepts with the constructivism theory, which states learning is not about imparting knowledge to students but the modification of the students' existing thinking. The predict-observe-explain (POE) method is a type of learning management based on constructivism theory. This learning encourages students to make decisions based on prior knowledge and beliefs. The POE

teaching method encourages students to express their opinions and discuss scientific concepts by asking questions and predicting what will happen if something changes. Then, students observe the situation after making a prediction by requiring students to conduct experiments, observe or find solutions in situations posed by the teacher. The students describe what they have observed. Finally of method in POE, the students explain what they know about the knowledge from what they observe or experience (Katanrat T. and Nanan S., 2015).

The modern physics course emphasizes at the university level the understanding of light as both particles and standing waves. The physics course at Yala Rajabhat University is classified as important science and focuses on the motion of electrons. Modern physics subject has been made mandatory for students studying physics and general science. In general, the study of electron particle motion and an abstract model. This made understanding the concepts of electron particle motion very difficult, as well as an inability to explain the connection between old theories and physics modern. It makes students misunderstandings the content of physics modern. As a result, it is critical to implement instructional activities that enable students to construct their own knowledge through observation and discussion of the results from their observations. In addition, by using software programs in teaching about electron particles, it will be easier to analyze and explain the motion of waves and particles.

The tracker program is an application built for the study of particle motion analysis. It is the most popular program for teaching physics and can create a motion model to transform experimental results into quantities and display the findings of the experiment in graphs and visuals. It makes students see the experiment's results more clearly (Pador S. and Dasaesamoh A., 2020). The tracker program has been utilized in several studies as part of teaching and learning. For example, projectile motion is studied using high-speed video analysis in mechanics (Wee, et al., 2015). A rocket tracker application was used to examine oscillatory motion. A study of students' critical thinking skills in the concept of free fall motion and responses by using media tracker (Wati, S., Halim, A, and Mustafa, 2020). Furthermore, the motion of material under gravity need to use the tracker program to calculate motion. Using the tracker application to analyze motion allows students to learn as student center. The tracker program is an assessing the spectral strength and reports it in brightness (Phommarach S., Wattanakasiwich P., and Johnston I., 2012).

Therefore, researchers were interested to do the research using the predict-observe-explain (POE) teaching method combined with the tracker program in order to develop scientific concepts and learning achievement of science student teachers in wave-particle duality topic. In addition, after learning researchers studied the satisfaction of science student teachers towards learning through the predict-observe-explain (POE) teaching method combined with the tracker program.

Objectives

1) To investigate conceptual understandings of science student teachers in wave-particle duality topic.
2) To study the learning achievement of science student teachers.
3) To study science student teachers' satisfaction towards learning through the predict-observe-explain (POE) teaching method combined with the tracker program.

Methods

Simples

The samples were 30 science student teachers from the general science program at Yala Rajabhat University in Thailand during the first semester of the 2021 study year. This research focused on

modern physics subjects, which was learning scientific concepts related to wave-particle duality topic.

Instruments

1) The two-tier multiple-choice questions used to assess conceptual understandings of wave-particle duality topic. There were 15 items, and each item had one blank space to write the reason for choosing the answer.

2) The pretests and posttests were closed-ended questions to assess the achievement of science student teachers. There are 25 items, and the pretest and posttest are the same set of tests.

3) The questionnaire on the satisfaction of science student teachers towards learning through the predict-observe-explain (POE) teaching method combined with the tracker program.

Data collection

The study employed the one-group pretest-posttest design for the samples. At the beginning of collecting data teacher provided science student teachers to do the pretest was by using the learning achievement test. Then, implementing the teaching wave-particle duality topic by using predict-observe-explain (POE) teaching method combined with the tracker program as follows;

1) Step of predicting (P): teacher asked the questions about the quality of light and provided science student teachers to predict.

2) Step of observing (O): science student teachers did the lab of electron diffraction and observe characteristics of electron diffraction from the lab. The teacher gave them to find the brightness radius of electron diffraction (d) and calculate wavelength (λ) by using the tracker program.

3) Step of explaining (E): in this step, science student teachers explained the characteristics of electron diffraction to summarize wave-particle duality.

After studying, the teacher provided science student teachers to do multiple-choice questions for assessing science misconceptions, a posttest by using the learning achievement test, and a questionnaire on the satisfaction of science student teachers towards learning through the POE teaching method combined with the tracker program.

Data analysis

1) Assessing conceptual understandings of science student teachers used five dimensions of conceptual understandings criteria. The detailed conceptual understandings criteria as described in table 1 as follows:

Table 1. Five dimensions of conceptual understandings

Conceptual understandings	Scoring criteria	Explorations of scoring
- Complete Understanding : CU	3	- Choose the correct answer and complete the explanation.
- Partial Understanding : PU	2	- Choose the correct answer but explanation is not complete.
- Partial Understanding with Specific Alternative Conception : PS	1	- Choose the correct answer but describe it incorrectly.
- Alternative Conception : AC	0	- Both of answer and gave description wrong.
- No Understanding : NU	0	- Not answer.

2) A pair sample t-test was used to compare the science achievement of science student teachers before and after learning physics modern through the POE teaching method combined with the

tracker program.

3) Mean and standard deviation was used to describe the satisfaction of science student teachers towards learning through the POE teaching method combined with the tracker program by using the following criteria:

Mean score	1.00 – 1.80	means	very satisfied
Mean score	1.81 – 2.60	means	satisfied
Mean score	2.61 – 3.40	means	neutral
Mean score	3.41 – 4.20	means	dissatisfied
Mean score	4.21 – 5.00	means	very dissatisfied

Results

1) Conceptual understandings

The results of conceptual understandings of science student teachers on wave-particle duality topic showed in table 2.

Table 2. Conceptual understanding of science student teachers on wave particle duality topic.

Items	Conceptual understanding of science student teachers on wave-particle duality topic (%)				
	CU	PU	PS	AC	NU
1	20.00	70.00	10.00	-	-
2	6.67	-	3.33	90.00	-
3	20.00	36.67	26.67	16.67	-
4	10.00	10.00	23.33	56.67	-
5	10.00	10.00	6.67	73.33	-
6	13.33	23.33	23.33	40.00	-
7	10.00	6.67	20.00	63.33	-
8	53.33	13.33	20.00	13.33	-
9	46.67	10.00	33.33	10.00	-
10	16.67	23.33	20.00	40.00	-
11	20.00	13.33	33.33	33.33	-
12	13.33	30.00	20.00	36.67	-
13	20.00	33.33	40.00	6.67	-
14	20.00	20.00	40.00	20.00	-
15	13.33	3.33	23.33	60.00	-

Note: CU: Complete understanding, PU: Partial understanding, PS: Partial understanding with specific alternative conception, AC: Alternative conception, NU: No understanding

Table 2 showed the results of science student teachers' conceptual understandings of wave-particle duality topic found that 53.33% and 46.67% of them were a complete understanding (CU) in item 8 (the experiment of electron diffraction, which phenomenon shows that particles can behave in

waves?) and item 9 (the equation of $\lambda = 2d\sin\theta$, which a sentence is correct?). In item 1, science student teachers at 70.00% were a partial understanding of the formulas of wave particles.

2) Learning achievement

The results of science student teachers learning achievement showed in the table 3.

Table 3. Learning achievement of science student teachers before and after learning.

Test	Number of Students	Mean	S.D	t	p-value
Pretest	30	10.00	3.063	-9.025	.000
Posttest	30	15.20	2.987		

$^{*}p < .05$

Table 3 showed the result of science student teachers' learning achievement and found that science student teachers were protesting significantly higher than before learning at .05 level of significance.

3) Science student teachers satisfied towards POE teaching method combined with tracker program

Most sciences student teachers were satisfied with teaching physics modern by using the POE teaching method combined with the tracker program and found that all of them were satisfied as shown in table 4.

Table 4. The satisfaction of sciences student teachers towards POE teaching method combined with tracker program

Items	N = 30		Level of satisfaction
	Mean	S.D.	
- Using POE teaching method combined with tracker program was interesting and easily to read the physics concept.	3.74	0.717	satisfied
- Using POE teaching method combined with tracker program helped me to have a better scientific concept of wave-particle duality topic.	3.81	0.692	satisfied
- Using POE teaching method combined with tracker program helped me to have a better of learning achievement in physics subject.	3.48	0.911	neutral
- Using POE teaching method combined with tracker program prompted me active in learning.	3.84	0.846	satisfied
- Using POE teaching method combined with tracker program provided me to learn by themselves.	3.46	1.654	neutral
- Using POE teaching method combined with tracker program prompted me to understand more in physics concept.	3.08	1.634	neutral
- Using POE teaching method combined with tracker program oppotonited to paticipante in techning and learning in class.	4.10	0.734	satisfied
- Using POE teaching method combined with tracker program provided me can use scientific skills in doing activities.	4.03	0.782	satisfied

Items	N = 30		Level of satisfaction
	Mean	S.D.	
- Using POE teaching method combined with tracker program given me line to study in physics.	3.65	1.033	satisfied
- Using POE teaching method combined with tracker program was very useful for teaching activities in the modern physics subject.	4.03	0.782	satisfied
Satisfaction	**3.722**	**0.979**	**satisfied**

Table 4 showed the result of science student teachers' satisfaction towards the POE teaching method combined with the tracker program found that the satisfaction was at satisfied level.

Discussion

The results of conceptual understanding of science student teachers on a wave-particle duality topic were approximately 53.33 % and 46.67 % of all of them were complete understanding (CU) in item 8 and item 9, respectively. For example, the question in item 8: “an experiment on electron diffraction, what phenomena show that particles can behave like waves?”. In this concept, most science student teachers choose the correct answer and complete the explanation about chased interference and diffraction. In terms of partial understanding (PU) found that science student teachers choose the correct answer but the explanation is not complete. Examples of the question that prompted them to have partial understanding were: "in the natural, light is a particle, what does it mean? and the question of item 12 “from a formula of λ=h/p, which variable is electrons as particles?”. Science student teachers' learning achievement found that learning achievement after study with the POE teaching method combined with the tracker program was posttest higher than pretest significantly at the statistical level of .05. The satisfaction of science student teachers towards POE teaching method combined with tracker program found that all of the science student teachers were satisfied level. They were interested and ensiled to read the concept of wave-particle duality topic, had acted in the activity, participated in teaching and learning in the class, and were very useful for teaching activities in the modern physics subject.

Conclusion

The conceptual understanding of science student teachers on a wave-particle duality topic found that they had a complete understanding (CU) of the content of wave-particle duality at 53.33% and some of them were a partial understanding (PU) about the formula of λ=h/p, which variable is an electron as particles at 70.00%. The learning achievement showed that most of them improved their score after studying by POE teaching method combined with the tracker program is significantly higher than before learning at .05 level. The satisfaction of science student teachers towards the POE teaching method combined with the tracker program found that all science student teachers were satisfied level.

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