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# An investigation of pre-service teachers' teaching active learning to be STEM Education

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**Abstract.** Teaching and learning in science class of Thailand focused on the teaching integrated approaches to STEM education. To enhance students to participate in doing an activity and learning in class in order to provide the students to more understand about the scientific contents. Therefore, the aim of this study was to investigate pre-service teachers' teaching active learning to be STEM education. In this studied, there were two pre-service teachers to be case studies, PST-A and PST-B. The data were collected by investigation lesson plans, classroom observation and interview. Then, the data were analyzed by grouping word by using the criteria of characteristics of active learning from Bonwell & Eison [3] and interpretation. The results found that PST-A and PST-B teaching corresponding to characteristics of active learning. The teaching activities of all of them were the feature of teaching activity in STEM education were; 1) students were development skills and engaged in doing activities such as practicing, observing, discussion, collaboration and calculation, this teaching and learning prompted students learn science by using science and mathematics in STEM, 2) students' learning was using simulation and video teaching about solar cell, this teaching and learning prompted students learn science by using technology in STEM, and 3) students are involved with higher order thinking and their attitudes such as analysis, design and creating, this teaching and learning prompted students learn science by using engineering in STEM. From the results shown that when pre-service teachers teach students with active learning in class could prompt students' learning to be STEM education.

## 1. Introduction

Teaching and learning in science class of Thailand focused on the teaching integrated approaches to STEM (science, technology, engineering, and mathematics) education. Most of about teaching in science try to improve and develop the teaching into STEM. The teaching hope that the approaches of STEM education can help the students in the next generation to solve problems in a real situation by applying concepts that receipted from the STEM education as well as the ability of critical thinking,



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collaboration, and creativity [4], [10], [11]. Although, STEM education plays important role in science teaching. However, in the present by studying in science, the teacher needs to use a process of active learning to teach students as also. To enhance students to participate in doing an activity and learning in science class in order to provide the students more understanding about scientific contents. Since, active learning is a teaching and learning encourages the students to engage in the learning process and participate in doing an activity. In addition, active learning, students can think by themselves about what they are doing of learning science. Furthermore, these teaching supports the students to collaborate in learning that providing them to interact with classmate and their teachers and provide the students to have analysis, synthesis and evaluate own knowledge in during of their learning [1]; [2] [3]; [8]; and [6]. Some of researchers refer to do criteria of active learning to evaluate teaching activity and students learning as shown in the table 1.

**Table 1.** the characteristics of active learning

Characteristics of Active learning
- Students are involved in more than listening
- Less emphasis is placed on transmitting information and more on development of students' skills
- Students are involved in higher order thinking
- Students are engaged in activities
- Greater emphasis is placed on students' exploration of their attitudes and values

However, there are many pre-service teachers in Thailand still perform as teacher center and lecture instruction [7]. The lecture instruction is the teaching that teachers transfer their knowledge to students [9]. This teaching prompts the students not have active learning and lack of using STEM education in class. Therefore, there are some researcher try to use STEM education and active learning to teach students in the Thai context to encourage the students more understand in scientific content. In addition, the instructor must come to understand the teaching of using active learning in science class in order to increase understanding of STEM education. Consequently, in this research study there has one research question to investigate of teaching and learning of pre-service teachers in Thailand about teaching active learning and STEM education is; how are pre-service teachers teaching active learning to be STEM education?

## 2. Methodology

This study employed a qualitative method which is a case-study research [5]. The participants of the study were two pre-service teachers, who were science teachers from science education program, Khon Kean University in Thailand. They were studying in 5<sup>th</sup> year of study and practicing in the school for one year, which they had four year experience in University and then a year of practicum in the school, primary school level or secondary school level. Two pre-service teachers selected to participate in this study by selecting from an observation classroom of studying in micro-teaching. Both of them were a good preparation of teaching activity when they studied in micro-teaching. After they studied in micro-teaching, two pre-service teachers were selected to be case-studies, which they designed to teach activities more about active learning in class.

### 2.1. Data collection

In the collecting data, two pre-service teachers (PST-A and PST-B) were investigated in the lesson plan and observed class of the teaching and learning, which they were observed for one time as shown in table 2:

**Table 2.** Observation classroom of teaching and learning in science class

Pre-service teachers	Times for observation	Topics of teaching
PST-A	1 hr. and 40 min	Electricity
PST-B	1 hr. and 40 min	Electric energy

In addition, there were interviews three students from each class of their teaching. In the study, there were used the triangulation to control the quality in this study.

### 2.2. Data analysis

The data of investigating lesson plan and observing the class analyzed by grouping words of characteristics of active learning from Bonwell & Eison (table 3) and interpreted teaching activity to be STEM. The data from students' interviews were interpreted.

**Table 3.** Criteria of active learning to evaluate teaching activity

Characteristics of active learning	Codes of active learning
- Students are involved in more than listening	Interaction, collaboration
- Less emphasis is placed on transmitting information and more on development of students' skills	Practicing
- Students are involved in higher order thinking	Analysis and Creating
- Students are engaged in activities	Writing, discussing, observing, brainstorming
- Greater emphasis is placed on students' exploration of their attitudes and values	Presentation

(Ref. Bonwell & Eison, 1991)

### 3. Research Findings and discussion

The results of the investigation the lesson plan and observation class of PST-A and PST-B teaching in class showed that teaching activities of PST-A and PST-B encouraged the students to participate in the learning. Moreover, the students interested and collaborated in making activity, and they practiced and learned by themselves as shown in tables 4, investigation the lesson plans.

**Table 4.** Criteria active learning of investigation the lesson plans

Characteristics of active learning	Pre-service teachers	
	PST-A	PST-B
- Interaction	√	√
- Collaboration	√	√
- Doing by themselves	√	√
- Analysis thinking or creating thinking	√	√
- Brainstorming	√	√
- Writing	√	√
- Discussing	√	√
- Observing	√	√
- Presenting	√	√

Note: PST -A: pre-service teachers-A, PST -B: pre-service teachers-B

Results from investigation lesson plan of PST-A and PST-B (a case study) interpreted that all of them created active learning in teaching science corresponding to criteria active learning including: 1) interacting, 2) collaborating, 3) doing activity by themselves, 4) observing, 5) higher or der thinking such as analysis, 6) discussing, 7) writing, 8) presenting, 9) brainstorming, and 10) commenting. In the table 5 shown the observation class of teaching and learning of PST-A, which taught students about electricity topic as following;

**Table 5.** Teaching and learning of PST-A in electricity topic

Teaching activities	Students' learning
- PST-A let students use simulation to study circuit and given students designed and did the electrical circuit in simulation. Then, let the students observed the results of doing electrical circuit.	- Students used simulation to find the electric circuit. They <b>designed together in doing electrical circuit</b> . Then, the students in each group <b>observed</b> the circuit in simulation and <b>calculated</b> to find the outcome of electricity. <b>Active learning:</b> Interaction, collaboration, observation, creating, practicing and calculation
- PST-A used the questions and asked students to discuss and analyze about the result from what they were outcome.	- The students discussed and analyzed of questions about why the resistance of series and parallel circuits were different. <b>Active learning:</b> Interaction, discussion and analysis.
- PST-A given students find the value of electric potential by themselves by using a simulation of circuits. Then given students find the outcome and presents to classmate.	- The students in group brainstormed to do the circuits and find the electric potential, which they calculated the electricity to find the electric potential and present to classmate. <b>Active learning:</b> Collaboration, practicing, branstroming, calculation and presentation.

The results from table 5 found that PST-A created the teaching and learning corresponding with characteristic of active learning, including; interaction, collaboration, practicing, writing, discussing, observing and presentation. In addition, the teaching activity found that PST-A provided the students to use simulation in studying circuit and let students designed and did the electrical circuit in simulation. This teaching prompted the students learn electricity by using technology and engineering in STEM. Furthermore, the teaching activity could prompt students practice in doing experiment and observe electrical by themselves. This teaching prompted students learn electricity by using scientific inquiry in STEM. From mathematic in STEM, students had calculated the value of electricity and voltmeter before they did the circuit in stimulation, and they calculated the outcome of electricity. In the table 6 shown the observation class of teaching and learning of PST-B, electric energy topic, as follow;

**Table 6.** Teaching and learning of PST-B in electric energy topic

Teaching activities	Students' learning
<ul style="list-style-type: none"> <li>- PST-B provided students to find electrical energy by using a solar cell and ammeter to set electric current. Then, PST-B let the student's discussion and find the outcome of electric energy.</li> </ul>	<ul style="list-style-type: none"> <li>- Students did a circuit by themselves in within the group. They used solar cell to find the electric energy by observing right bulb and answer the hypothesis in the experiment. <b>Active learning:</b> Interaction, observation and creating</li> </ul>
<ul style="list-style-type: none"> <li>- PST-B used questions to help the students brainstorm and discuss in doing experiments. For examples, "how is the battery generates the electricity?", "why you believe the solar cell will generate electricity?". Then, PST-B enhanced the students to discuss and calculate the outcome from experiment.</li> </ul>	<ul style="list-style-type: none"> <li>- Students observed the bright bulb, when they used battery, sun and solar cell generates the electricity. In this experiment, students in each group discussed and brainstormed to calculate the outcome from experiment. <b>Active learning:</b> Interaction, collaboration, observation, practicing, brainstorming, discussion, creation and writing</li> </ul>
<ul style="list-style-type: none"> <li>- PST-B let students use about material to make solar cell to generate the electric current besides the sun, such as flashlight, laser beam and battery to students analyse and present the differences.</li> </ul>	<ul style="list-style-type: none"> <li>- Students created circuit by using a several of electric power source, such as a flashlight and laser beam to find the electric energy. Then, they observed and analyzed the right bulb and present to classmate. <b>Active learning:</b> Interaction, collaboration, observation, practicing, brainstorming, discussion, creating, writing and presentation</li> </ul>

Result from table 6 found that PST-B created the teaching and learning corresponding with characteristic of active learning, including; interaction, collaboration, practicing, writing, discussion, observing, brainstorming and presentation. The teaching activity found that PST-B provided the students to create circuit by using solar cell in making the brightest bulb. PST-B were a several of

power source such as the sun, flashlight, laser beam and battery in order to students observed and did the experiment to find a feature of right bulb. This teaching prompted the students learn the electrical energy by using engineering and scientific inquiry in STEM. In addition, PST-B used video of using solar cell in real situation in order to students find a reason of electric energy occurring and prepare with the circuit of students doing in class. This teaching prompted students learn the electric al energy by using technology in STEM. Furthermore, after students did experiments, they calculated the electric current from ammeter to find the outcome of electric energy. This teaching prompted students learn the electrical energy by using mathematic in STEM.

In addition, the results of interviewing the students found that the students participates in doing activities of learning and they could create the circuit by themselves. Some students' interview as follows; S1: "teacher let me do circuit by using solar cell to find look the brightest bulb when I used a flashlight, laser beam, battery and the sun to give the power source", and S2: "I could understand more about the knowledge of occurring the electricity when I used simulation in doing the circuits"

#### 4. Conclusion

The teaching and learning of PST-A and PST-B corresponding to characteristics of active learning, which the teaching activities of their teaching were the feature of teaching activity to be STEM. From the research question was; how are pre-service teachers teaching active learning to be STEM education? It was shown that the teaching and learning of PST-A and PST-B of using active learning that encouraged the teaching activity to be STEM were; 1) students were development skills and engaged in doing activities such as practicing, observing, discussion, collaboration and calculation, this teaching and learning prompted students learn science by using science and mathematics in STEM, 2) students' learning was using simulation and video teaching about solar cell, this teaching and learning prompted students learn science by using technology in STEM, and 3) students are involved with higher order thinking and their attitudes such as analysis, design and creating, this teaching and learning prompted students learn science by using engineering in STEM. Consequentially, the results of using active learning in teaching science shown that when pre-service teachers teach students with active learning in class could prompt students' learning to be STEM education.

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