

Development of problem-solving skill by using active learning for student teachers in Introductory Physics

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Abstract. This research was to study student teachers' problem-solving skill after they took active learning Introductory Physics class in academic year 2017. There were 101 student teachers taking the course as a compulsory for 17 weeks. The one group pre-test and post-test design was used as quantitative research and also qualitative research. Twelve active learning activities were used throughout the whole semester. The IPST problem-solving assessment and rubrics were used to develop the research instrument to evaluate students' problem-solving skills. The focus group interview was conducted to collect qualitative data on student teachers' opinions of active learning activities. The paired-sample t-test was applied to compare problem-solving scores before and after they took in the class. The interview data, content analysis was used to summarise students' opinions. The results indicated that their problem-solving skills were significantly higher after learning through active learning activities at .05 confident levels. Students' opinions mostly reflected the positive feeling toward active learning activities and they recommended for other classes to use the same pedagogy.

1. Introduction

Active learning is an important strategy for student skills development which students become as active participants in their own class. Meyers and Jones have maintained that the active learning consists of three factors that are basic elements; learning strategies; and teaching resources [1]. Bonwell and Eison also summarized the literature on active learning and concluded that it led to better student attitudes and improvements in students' thinking and writing [2].

A study of Sivan shows that students who received an education through active learning and student-centered learning had developed problem-solving skills as well as their critical-thinking ability [3]. Kalem and Ferr had studied the effects of a model designed for active learning on the students' learning. They found that the university students agreed that this teaching method had positive effects in the view of their learning, teaching, and communication [4]. It was also determined that their attitudes and successes were effectively increased by using active learning techniques. Even though many researches indicated that active learning strategies are effective, in Physics teaching is still needed to apply this method as mention in the study that Heller and Hollabaugh conducted in Turkey [5].

In 21st century, solving complex problems has been recognized as essential for all citizens [6]. Physics itself serve as a foundation for disciplines in all technology, it is an ideal venue for teaching problem solving. However, the number of researches in active learning in Physics is still a few including enhancing problem-solving skill [7].

Therefore, the main purpose of this study was to use active learning activities to develop student teachers' problem-solving skills. The case study was conducted in Introductory Physics. This course was required for undergraduate teaching program in general science education at faculty of education, Suan Sunandha Rajabhat University (SSRU), Bangkok, Thailand.

2. Theory

2.1 Active learning in Physics

Active learning is defined as any instructional method that engages students in the learning process. The core elements of active learning are student activity and engagement in the learning process [8].

These were 4 characteristics of active-learning instructional methods in Physics for this study based on Meltzer and Thornton in 2012 [9].

- (a) Instruction to specific learning difficulties related to particular Physics concepts and knowledge elements.
- (b) Students engage in a variety of problem-solving activities during class time.
- (c) Students often work together in small groups.
- (d) Problems are posed in a wide variety of contexts and representations.

2.2 Assessing problem-solving in Physics

One popular method to evaluate problem-solving skill is rubrics that can assess complex behaviour in authentic situations. Because rubrics can be used to quantify different dimensions of performance. The key component of problem-solving skill was measured based on as follows: 1) describe the problem in Physics terms, 2) plan a solution, 3) execute the plan, and 4) check and evaluate [8,9].

3. Methodology

This study is quantitative and qualitative research. The one-group pre-test and post-test design was used to compare students' problem-solving skill. There were 101 undergraduate student teachers in general science program at Suan Sunandha Rajabhat University, Thailand participating for 17 weeks, academic year 2017. Problem-solving skill was assessed by using student's written problem solutions rubric based on Institute for Promoting Science and Technology Teaching in Thailand or IPST [10]. This IPST assessment form focused on student's performance in solving the problems step by step. There are several forms to assess students' science skills however this study used only one of them. The focus group interview was used to collect the qualitative data on students' opinions.

This study was aimed to answer two research questions:

- (1) Was there any significant different between student teachers' problem-solving skill before and after they learned by using active learning activities in Introductory Physics course?
- (2) What was student teachers opinion toward active learning activities in Introductory Physics course?

The 12 active learning activities used in this study were consisted of the topics in classical mechanics; one dimension motion, two dimension motion, force, application of newton's law of motion, momentum, mechanical energy, and rotational of rigid body. The variety of problem-solving in active-learning based were used including giving feedback and a small group project to solve Physics problems. These were two example questions used to ask students to write down their answers.

- If you want to walk from the main gate of grand palace to faculty of education, SSRU with the least time, what is the best way to do it and why?
- You have two equivalent grocery bags and you want to carry them from level 1 to level 6 of your education building. How can you do to get the least work done by yourself and why?

There are 4 steps to evaluate students' problem-solving skill mainly based on IPST. There are step 1- understand the problem, step 2- decide how you are going to solve the problem, step 3 - solve the problem, and step 4 - look back and check. Then in each step the rubrics criteria were used to assess students on the scales of 1-5. The example of step 1 rubric scores are as follows: 1 = student does not understand the problem at all; 2 = student show some part of understanding the problem; 3 = student shows fairly understanding the problem; 4 = student shows the evident of most understanding the problem; 5 = student shows the fully understanding the problem.

4. Results

All 101 Student teachers taking Physics had been evaluated problem-solving skill based on 4 steps with 5 rubric scores before and after the class. The total of the score was 20. The results of their problem-solving score from pre-test and post-test were shown in table 1. It indicated that their problem-solving skill have significantly higher at .05 confident level after they took active learning Introductory Physics class. The some part of results also showed no significantly different between female and male students' scores on problem-solving.

Table 1. Student teachers' problem-solving scores.

Test	Mean	SD	df	t	P-value
Pre	7.73	0.91	100	72.28	P < 0.05
Post	17.07	0.83			

There were 20 student teachers from Physics class participating in the focus group interview. The 5 questions on what their opinions were asked. The 30 minutes focus group interview were used at the end of semester. After using content analysis the results indicated that mostly students felt strongly positive on active learning activities in Physics class as shown in table 2. Female students were more appreciated in participating while working as a team than male since it helped them feeling more confident to share and speak their mind.

Table 2. Students' opinions of using active learning Physics and problem-solving skill.

Questions	Summary
1. What do you think about active learning before you taking Physics course?	<i>All students agreed that they are not sure what is actually active learning and how it would be taught in Physics.</i>
2. What do you think of your problem-solving skill before taking Physics?	<i>90% of students think that their problem-solving skills are not good and some of them are not sure how to define this skill.</i>
3. What do you think about active learning activities?	<i>All students think that active learning activities are very useful. It allows them to work on their own, to share, and to discuss.</i>
4. What do you think of your problem-solving skill after finish Physics course?	<i>95% of students think that their problem-solving consisting of 4 steps are better and that is because of they learn by using active learning. 5% of students think that most likely their problem-solving skills have improved and that is because of both their own interest in Physics and active learning activities.</i>
5. Would you recommend active learning in Physics to others? If yes, why?	<i>All students would recommend using active learning in other Physics class. Because they feel more enjoyable and safe in their classroom.</i>

5. Discussion and conclusion

Introductory Physics course at SSRU is characterized by active learning for student teachers in academic year of 2017. This method helps students to have greater problem-solving skill in Physics as well as positive opinion of learning in Introductory Physics course.

This approach creates a learning surrounding in which students enjoy learning Physics. The main reason behind these satisfactions is their roles as owner to their own learning and sees how Physics knowledge can be useful to them.

The results indicated that student teachers problem-solving skill improved after learning through active learning activities in Physics is the same as the result from Sivan research in 2004. The students' opinion of active learning activities which allow them to discuss can improve their communication skill and the positive feeling toward Physics class as also shown in 2003 the study of Kalem and Fer.

This study has led to results and conclusion that can significantly improve the quality of Physics teaching, students' interest in Physics as an undergraduate subject and can also increase their problem-solving skill and Physics related careers especially in teaching career as shown in the results of the many studies [9,11]. These are the potentially useful messages for teachers and researchers:

- The active learning, as the new Physics teaching method in this paper, is necessary to help student teachers develop problem-solving skill as well as better feeling in learning Physics.
- It is recommendable to allow students in the class to discuss and share understanding in Physics among their peer that would motivate and challenge them and include them in the active content learning.

References

- [1] Meyers C and Jones T B 1993 *Promoting Active Learning, Strategies for College Classroom* (San Francisco: Jossey Bass Publishers)
- [2] Bonwell C C and Eison J A 1991 *Active Learning: Creating Excitement in the Classroom*, ASHEERIC Higher Education Report No.1 (Washington: George Washington University)
- [3] Sivan A, Leung R W, Woon C, Kember D 2000 *Innov. Educ. Teach. Int.* **37** 381
- [4] Kalem S and Fer S 2003 *Educ. Sci.-Theor. Pract.* **3** 455
- [5] Heller P and Hollabaugh M 1992 *Am. J. Phys.* **60**(7) 637
- [6] Jennifer L D *et al* 2016 *Phys. Rev. Phys. Educ. Res.* **12**, 010130
- [7] Jonsson A and Svingby G 2007 *Educ. Res. Rev.* **2** 130
- [8] Prince M 2004 *J. Eng. Educ.* **93** 223
- [9] Meltzer D E and Thornton R K 2012 *Am. J. Phys.* **80**(6) 478
- [10] IPST 2016 *Problem-solving Assessment* (Bangkok: IPST publishing)
- [11] Karamustafaoglu O 2009 *Energy Educ. Sci. Tech., Part B* **1**(1) 27