Analysis of pre-service physics teacher skills designing simple physics experiments based technology

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Abstract. Pre-service physics teacher skill in designing simple experiment set is very important in adding understanding of student concept and practicing scientific skill in laboratory. This study describes the skills of physics students in designing simple experiments based technologically. The experimental design stages include simple tool design and sensor modification. The research method used is descriptive method with the number of research samples 25 students and 5 variations of simple physics experimental design. Based on the results of interviews and observations obtained the results of pre-service physics teacher skill analysis in designing simple experimental physics charged technology is good. Based on observation result, pre-service physics teacher skill in designing simple experiment is good while modification and sensor application are still not good. This suggests that pre-service physics teacher still need a lot of practice and do experiments in designing physics experiments using sensor modifications. Based on the interview result, it is found that students have high enough motivation to perform laboratory activities actively and students have high curiosity to be skilled at making simple practicum tool for physics experiment.

1. Introduction
Learning physics provides a range of process skills are skills using tools, logical thinking skills, critical thinking skills, generic science thinking skills, problem solving and decision making. Simple experiments provide experience, individual student participation, student participation in groups, scientific methods, and scientific procedures [1]. Scientific experiments are expected to be effective in applying long-lasting concepts in students' memories and understanding. Students can be trained to apply concepts in real life experiences including conceptual application as well as attitudes and skills [2]. One of the advantages of learning through simple experimental designing activities is that students can repeat the same activities to find the right results, a lot of experience and a perfect tool design [3]. In designing simple experiments, students will arrange the activity sheets as guidelines for the procedure of activities to achieve the objectives of a particular experiment [4]. Based on observations in the basic physics lab course of the last three years, students lack the skills to solve problems, skills to perform scientific procedures, thinking skills, reasoning and decision making. In addition, the mathematical approach to solving the problem is still low.

Based on the problems faced by apprentices in schools, it is deemed necessary to develop simple experiments to use practicum tools available in school laboratories and practicum labs that are not yet available in school laboratories [4]. In addition, schools require student worksheets, modules, and assessments [5]. Practical tools or visual aids and student activity sheets need to be developed as guides for applying lessons that support the achievement of students' knowledge, attitude, and skills competencies [6]. It contains several work steps including thought processes, work procedures,
creativity, and investigative activities to rediscover the concepts, principles, rules, and laws of physics. Using a student assignment approach to designing simple experiments is guided to solve problems based on the facts encountered [7]. The assignment of designing simple experiments can be applied to various learning methods through experiments, assignments and field studies.

In physics, research-based learning tends to be implemented in the form of practicum activities. By conducting laboratory activities, students are represented with scientific processing skills [8]. These skills give students the opportunity to search for information, hypothesize, data collecting, data analyze, and make inferences based on life experiences. Implementation of research-based learning through practicum is so that students have the ability of scientific processing and character of a scientist [9]. The ability to design simple experiments in physics has become a focus to equip students with the skills of applying the concept of physics. Skills are one of the categories of thinking skills used by prospective teachers to teach their students thinking. Skills implemented to build knowledge of physics or introduce a culture of science.

Student attitudes toward learning and problem solving in science and their concepts of science learning goals can have a significant effect on understanding their concepts. In the skill, there is scientific reasoning because skills give effect to change and increase emotional and cognitive abilities [10]. In physics education problem solving is usually used to understand the physics and the right strategy can help students transfer their knowledge. When someone tries to solve a problem through making a simple experimental design, they will create a model in their minds about how to identify a problem to solve the problem. Two approaches used by students in problem solving. Approach that uses the concept of physics to be applied, planning solutions, revisions and evaluation. Other approaches are structured approaches ranging from making designs, determining known and unknown variables, choosing equations, and correcting answers. In relation to the above, this study aims to describe the results of student physics teacher candidate analysis in designing simple experiments with loaded technology.

2. Methods
This study uses a descriptive research design and uses participants consisted of 25 pre-service teachers studying in physics education department. A focus group interviews and observation with pre-service teacher for knowing description of skills for experiment set design (Gall & Borg, 2003). Data were collected during 4 month of 2016-2017 academic years. Questionnaire for observations was used to collect data for skills description and questions list for interviews was used to collect data for each special skills of group course. The experimental design stages include simple tool design and sensor modification. Pre service teacher were asked to determine their agreements or disagreements and reason about 10 questions. Pre-service physics teacher were seen to experiment design their work on a five-point Likert scale ranging from 1 to 5 is 5 indicating strongly agree and 1 indicating strongly disagree. Interviews could check if pre-service physics teacher perceive the matter of process experiment design in the same way and pre-service teacher regard things different than each group course. A observation sheet of pre-service physics teacher were shown to intrigue the discussion on pre-service teacher perceive their leaning process and instructors perceive that these problems for experiment set each group.

3. Result and Discussion
Simple Trial Design this research produced 5 simple experimental designs, LDR Diffraction Sensor, Beam Measurement of the EM, Business Sensor, Wave Tank and Simple Modern Swing. The design of simple experiments can be seen in Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5.
Figure 1. LDR diffraction sensor

Figure 1 The Diffraction LDR Sensor is made of metal or glass plates which on the surface are scratched by parallel lines with very large numbers. Diffraction is defined as an event of spreading or deflecting a wave as it passes through the opening or around the end of the barrier. The amount of diffraction depends on the size of the barrier and the wavelength. A grid with a width of approximately 2 cm has scratches or lines up to as many as 10,000 or 20,000 lines. The lines between the two scratches can be viewed as a gap, and the interference of 20,000 slits forms a narrow (narrow) constructive and narrow (destructive) line, with positions dependent on the wavelength.

Figure 2. Beam measurement of the EM

Figure 2 Beam measurement of the EM used to determine the value of mechanical energy and to determine what factors affect the mechanical energy. The potential energy that objects possess because of their position. The magnitude of the gravitational potential energy is proportional to mass, the acceleration of gravity and density, the kinetic energy that an object because of its motion.

Figure 3. Work Sensor

Figure 3. Work Sensor to analyze the effect of distance on size of the effort generated and measure the effort of an object when measured from different distances. This experiment set applies the concept of Newton's Law.
Figure 4. Wave Tank as a simple experiment to describe the nature of light diffraction, reflection, refraction, and interference. The effect of gap distance on wave behaviour shows diffraction. The effect of the glass height on the wave behaviour shows refraction. The influence of cast iron distance on the wave behaviour shows reflection. The effect of two coherent waves on the wave behaviour indicates interference.

Figure 5. Simple Harmonic Motion

Figure 5. Simple Harmonic Motion to determine the period of objects. The acceleration of gravity is influenced by the period of the object, the acceleration experienced by the body because of its own weight which is influenced by the gravity of the earth. The object is said to move or vibrate harmoniously if the object is swinging through equilibrium or back again to the starting position. Simple harmonic motion is the motion of alternative the object through a certain equilibrium point with some vibration of an object in every second always constant. The result of observation of 5 groups can be seen in Table 1.

Initial group ability is not measured advance, group students random without considering initial abilities. The skill of designing a simple physics experiment conducted by group 1 on LDR diffraction sensor shows that the student is good in determining the tool and arrange Arduino while for the test still require the design of variation of practice. The skill of design a simple physics experiment conducted by group 2 on Beam Measurement of the EM shows that students are less skilled in assembling tools, tool modifications and load variations. The skill of design a simple physics experiment conducted by group 3 on work sensor shows that students are good at gathering tools and materials, tools assembly and variations experiment. The skill of design a simple physics experiment conducted by group 4 on wave tanks shows that students are less skilled in assembling experimental tools and data retrieval at the time of trial not yet obtained. The skill of design a simple physics experiments conducted by group 5 on simple harmonic motion shows that students are less skilled in tools assembly and data test retrieve. However, difficulties in sensor modification.
Table 1. Results Observation Simple Trial Design Process

| Group | Experiment set | Process | Psychomotor Skill |
|-------|----------------|---------|------------------|
|       |                |         | Maximum | Score | Mean | %   |
| 1     | LDR            | 1. collection of tools | 15 | 12 | 11.8 | 78.5 |
|       | Diffraction Sensor | 2. the basic sequence of Arduino strings | 15 | 11 |     |     |
|       |                | 3. tools assembling and testing | 15 | 12 |     |     |
| 2     | Beam Measurement of the EM | 1. tools assembling | 15 | 11 | 10.6 | 70.4 |
|       |                | 2. tool modification | 15 | 11 |     |     |
|       |                | 3. load variation | 15 | 10 |     |     |
| 3     | Work Sensor    | 1. sensor design | 15 | 7 | 7.8 | 51.9 |
|       |                | 2. tool circuit | 15 | 8 |     |     |
|       |                | 3. variation of distance and load at fixed angle | 15 | 8 |     |     |
| 4     | Wave Tank      | 1. collection of tools and materials | 15 | 11 | 10.3 | 68.9 |
|       |                | 2. circuit tool | 15 | 9 |     |     |
|       |                | 3. trial set | 15 | 11 |     |     |
| 5     | Simple Harmonic Motion | 1. sensors design | 15 | 8 | 9.5 | 63.1 |
|       |                | 2. buffer design | 15 | 10 |     |     |
|       |                | 3. data retrieval | 15 | 9 |     |     |
|       |                | 4. sensor test | 15 | 10 |     |     |
|       |                | 5. Tool trial | 15 | 9 |     |     |
|       |                | 6. refining of tools | 15 | 10 |     |     |

3.1 Results of Interview Analysis

Interview result obtained by skill description obtained by student each stage of experiment completion process can be seen in Table 2.

Table 2. Interview description of experimental process

| Aspect interviews | Interview Description |
|-------------------|-----------------------|
| Skill selection and use of tools and materials | We choose tools and materials that are easily formed and easy to obtain |
| Skills create basic circuit design | We make the circuit design using the required sensor according to the quantity to be measured |
| Design the sensor | We designed the sensors to be used as measuring devices using a variety, modification and sensor application is still not good |
| Modify a simple experimental tool | We had trouble modifying a simple experimental tool |
| Variations of data retrieval | We provide variations of data collection over 3 variations |
| Trial of laboratory-scale experiments | We conducted a laboratory-scale test of 2 times each variation of the lab. We make experimental refinements from the aspect of display, usage, and precision |
| Completion of experimental tool | |
Based on the interviews description was found that students designed simple experiments through several stages that resulted in selecting skills and using tools and materials, basic circuit design skills, simple experimental set skills, sensor design skills, modified simple experimental skills, laboratory experiments on laboratory scale and skill in improving experimental tools.

The results of this study are relevant to the study as a theoretical contribution, experience moves during experiment set design in physics laboratory would be a way to identify empirically how simple experiment set design with technology skill. Simple experiment set has different potential strengths for learning outcomes describe as possible appropriate objectives for inquiry in laboratory [11]. Practical work activities show pre-service physics teacher performance skill [12]. Collaboration and communication student always show during such work [13]. Pre-service physics teachers might use the questions to design activities, with some ideas for different purposes. By identifying interaction and content during activities, conclusions of the activity supports the teachers’ purposes and students’ aims for simple experiment set design.

4. Conclusion
There are 5 simple experimental designs, LDR Diffraction Sensor, Beam Measurement of the EM, Work Sensor, Wave Tank and Simple Harmonic Motion. Based on the results of interviews and observations obtained the results of student skill analysis in designing simple experimental physics charged technology is good. Based on observation result, student skill in designing simple experiment is good while modification and sensor application are still not good. This suggests that students still need a lot of practice and do experiments in designing physics experiments using sensor modifications. Based on the interview result, it is found that students have high motivation to perform laboratory activities actively and students have high curiosity to be skilled at making simple practicum tool for physics experiment.

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