Pre-service teacher's physics attitude towards physics laboratory in Aceh

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Abstract. This research aims to find out the pre-service teacher’s physics attitude towards physics laboratory in one of the Universities in Aceh. The research method uses a quantitative descriptive approach. Data collection techniques used a scale questionnaire that was adapted from several previous researchers. The Subject of this study is 45 physics student prospective students who were taken from the semester, II, IV, and IV as subjects of the study. The data analysis technique is done by calculating the mean of each aspect and indicator and the independent t-test to see differences in attitudes based on gender. Overall, the results of the study showed a negative attitude towards physical practicum activities with the acquisition of a mean of 2.78. The statistical test results for normally distributed and homogeneous data show no significant differences (df. 43, sig. 0.90 > 0.04) between the attitudes of male and female students. Negative attitudes towards physics laboratory are caused by the design of practicum verification that does not provide benefits to improve understanding, practice scientific inquiry skills, thinking skills, and solving physics problems. Efforts to improve attitudes toward physics practicum can be done through the design of practical activities oriented to humanistic psychology and constructivism by involving students actively investigating.

1. Introduction
Over the 20th century, laboratory activity has become the main characteristic of science learning. The role and function of the laboratory in practical activities are very important to describe the material theoretically as verification to prove the theory, concept, and law. Besides, students to sharpen their skills to solve physics problems can also use the laboratory. The laboratory can also be used as a good learning environment to foster a positive attitude, stimulate interest and pleasure, and motivate students to study science and physics in particular [1].

An attitude is a form of psychological state that determines the response of a stimulus in the form of action or behavior. The tendency of attitudes can take the form of acceptance (positive attitude) or rejection (negative attitude) of an object [2]. The study of student attitudes toward science explains the relation of the problem of students who often isolate themselves from being involved in the subject of science. The tendency of negative attitudes toward science can make learning more difficult to learn. Thus the positive attitude towards science can stimulate students to do business that can increase motivation and achievement in learning science [3].

The 2015 Science Framework for PISA illustrates that aspects of attitude together with the context and knowledge of students are one of the three aspects that affect student competency that is expected
to be able to explain facts and scientific phenomena [4]. Aspects of attitude towards science shown by interest in science and technology; assess scientific approaches to investigation, if necessary, and perceptions and awareness of environmental problems.

In physics learning, attitude toward physics into four categories, namely feeling fond towards physics, pleasuring in the process of learning physics, understanding of physics compared to other problems, and understanding practice in learning physics [5]. The other research found the attitude toward physics into six categories, namely interest, career, the importance of physics, teachers, difficulties in learning, and equipment used in learning physics [3]. Furthermore, Kamba et al. developed parameters of attitude toward physics into four categories, namely student self-concept, anxiety in learning physics, fear of physics learning, and aspiration [6].

The result of the literature study shows that many researchers before have carried out studies of attitudes towards physics, but the study of student attitudes towards physics practicum is still limited. Assessing students’ attitudes towards physics practicum activities is a contribution to finding out what happened in physics laboratory activities. Regarding the relationship between attitudes and academic achievement, the researchers previously concluded that there was a significant relationship between attitudes and student academic achievement in learning science and physics [7, 8]. However, students’ academic achievement in physics learning is still low. It causes students’ attitudes towards physics. Therefore, attitude observation is very important to conduct in the learning process and mental processes related to attitudes in conducting scientific investigations, especially in physics learning. The purpose of this study was to find out the attitudes of students towards physics laboratory in the study program of physics education in Aceh Province.

2. Methods

This study uses a quantitative descriptive approach. The approach is used as a way to calculate and analyze data in the form of numbers collected through questionnaires. From the results of quantitative data processing, it is also hoped that data and information related to Attitude Toward Physics Laboratory will be more consistent and valid. While the descriptive method is used to describe the overall factual conditions of the Attitude Toward Physics Laboratory. At the interpretation stage, this method is used as a way of interpreting the results of the analysis of data obtained in the form of numbers, verbal/non-verbal statements/questions in detail, concise and clear. The subject of the study was 45 pre-service physics teachers consisting of 15 men and 30 women from semesters: II, IV, and VI in State University in Aceh. Data collection uses an attitude scale questionnaire on physics practicum adapted from previous by adjusting according to the purpose of this research [5, 6, 9]. This questionnaire is a closed questionnaire type containing 30 items of the question with four response options in the form of a checklist.

Fourscales for response options were chosen with the aim that there is no opportunity for respondents to be neutral so that respondents can express their attitude firmly to the questions posed in the questionnaire. The Attitude towards Physics Laboratory aspect measured is the interest in physics practicum, the benefits of physics practicum, the importance of physics practicum activities, anxiety in the physics laboratory, the desire to study in physics laboratories, and physics laboratory facilities. The measurement data has calculated the mean of each aspect and indicator to find out the positive or negative responses to the questions asked. Positive attitude if Mean > 70% or Mean > 2.8 (scale 4), and negative attitude if Mean < 70% or Mean < 2.8 [9]. Furthermore, an independent t-test was run to determine the differences in the attitude of pre-service physics teachers towards physics practicum. Before a statistical test is carried out, the Kolmogorov Smirnov test uses the normality and one-way ANOVA test to ensure that the data is normally distributed or not.

3. Result and Discussion

3.1. Result

The measurement results of the Attitude toward Physics Laboratory Questionnaire Pre-service teacher physics grouped in several aspects and indicators, as shown in Table 1 below.
Table 1. Recapitulation of Results of Questionnaire Measurement Attitude Toward Physics Laboratory Perspective Physics teacher students at one of the State Universities in Aceh.

| No. | Aspect | Indicator | ATPLab indicator | Gender |
|-----|--------|-----------|------------------|--------|
|     |        |           | Mean | Male | Male | Female | Female | Remark |
| 1   | Interest in physics | 1. Demonstrate an attitude of pleasure towards learning physics | 2.79 | Negative | 2.87 | Positive | 2.75 | Negative |
|     |        | 2. Interest in practicum activities | 2.74 | Negative | 2.70 | Negative | 2.77 | Negative |
|     |        | 3. Enthusiastic Attitudes Following Practicum | 2.77 | Negative | 2.80 | Positive | 2.76 | Negative |
|     |        | 4. Perseverance follows practicum activities | 2.87 | Positive | 2.87 | Positive | 2.88 | Positive |
|     |        | Average Score | 2.79 | Negative | 2.81 | Positive | 2.79 | Negative |
| 2   | Benefits of practicum physics | 5. Practicum benefits of physics to support a career | 2.84 | Positive | 2.93 | Positive | 2.80 | Positive |
|     |        | 6. Practical benefits of physics everyday life | 2.91 | Positive | 2.93 | Positive | 2.90 | Positive |
|     |        | 7. Supporting the understanding of the concept of physics | 2.69 | Negative | 2.53 | Negative | 2.77 | Negative |
|     |        | Average Score | 2.81 | Positive | 2.80 | Positive | 2.82 | Positive |
| 3   | The importance of practical physics Activities | 8. Generating Motivation to Learn Physics | 2.80 | Positive | 2.80 | Positive | 2.80 | Positive |
|     |        | 9. Train Basic Skills in Conducting Experiments | 2.51 | Negative | 2.47 | Negative | 2.53 | Negative |
|     |        | 10. Practical Activities As A Vehicle For Learning Scientific Approaches | 2.80 | Positive | 2.60 | Negative | 2.90 | Positive |
|     |        | 11. Train 4 Cs skills and problem-solving | 2.73 | Negative | 2.87 | Positive | 2.77 | Negative |
|     |        | Average Score | 2.71 | Negative | 2.68 | Negative | 2.75 | Negative |
| 4   | Anxiety in a physics laboratory | 12. Anxiety Using Physics Tools and Materials | 2.73 | Negative | 2.77 | Negative | 2.72 | Negative |
|     |        | 13. Anxiety in physics practicum | 2.81 | Positive | 2.87 | Positive | 2.78 | Negative |
|     |        | Average Score | 2.77 | Negative | 2.82 | Positive | 2.75 | Negative |
| 5   | The Desire to Learn Physics in the Laboratory | 14. Willingness to study physics in the laboratory | 2.64 | Negative | 2.67 | Negative | 2.63 | Negative |
|     |        | 15. Confidence in physics practicum | 2.93 | Positive | 2.67 | Negative | 3.07 | Positive |
|     |        | Average Score | 2.79 | Negative | 2.67 | Negative | 2.85 | Positive |
| 6   | Physics Laboratory Facility | 16. Availability of physics lab tools and materials | 2.78 | Negative | 2.67 | Negative | 2.83 | Positive |
|     |        | 17. Physical measuring instruments supported by ICT | 2.79 | Negative | 2.87 | Positive | 2.75 | Negative |
|     |        | Average Score | 2.78 | Negative | 2.77 | Negative | 2.79 | Negative |
|     |        | Total Score | 2.78 | Negative | 2.76 | Negative | 2.79 | Negative |

Description: Positive if the acquisition of mean $\geq$ 2.80, negative mean $<$ 2.80

Based on Table 1, it can be seen that the mean of the pre-service teacher's attitude towards laboratory attitudes toward physics laboratory was 2.78 and indicating a negative attitude. Next, to find out whether there are differences in attitudes based on gender between male and female physics teacher students, an independent t-test was conducted for normally distributed and homogeneous data. The results of the Shapiro-Wilk normality test using SPSS version 25 showed that both groups of data were normally distributed with a significance level of 0.98> 0.05 male group, and a significance level of 0.526> 0.05 female groups. The One-Way ANOVA Homogeneity Test shows a significance level of 0.58> 0.05; it can be concluded that the two groups of data are homogeneous. The independent t-test was obtained df. 43 Sig. (2-tailed) 0.909> 0.05; it can be concluded that there is no significant difference in the attitudes of male and female physics teacher students towards practicum in the physics laboratory. These results indicate that in general, there are similarities in views and attitudes between male and female students to what they portray and experience during the implementation of physical practicum activities.


3.2. Discussion

3.2.1. The aspect of Interest in Physics Practicum

Enthusiasm shows that the students like and pleasure of physics practicum. The results of students' attitude toward physics practicum showed 2.79 of the pleasing indicator, 2.74 of interesting in physics practice, and 2.77 of taking part in physics practicum. All of them show negative responses or less interested in activities physics practicum. While the indicators of perseverance participating in practical activities gained a positive response with a mean score of 2.87, it's mean that they were engaged in participating in practical activities.

One of the reasons for the lack of interest in physics practicum for students is the practical design presented. The results of practicum observation show that the practicum design applied is a verification practicum design, where students only follow detailed experimental procedures without being involved in how the procedure is obtained. As a result, students only follow the practicum steps given, thus severely limiting the student's space to explore concepts and physical phenomena independently. Such this practice makes the learning experience of physics less memorable, which has an impact on the negative attitude of the physics learning process. A pleasant experience in learning physics, both inside and outside the classroom is one of the situations that can deliver the flow of students so that it gives birth to a sense of mastery on physics materials [10]. Flow is a condition where students are deeply absorbed in a learning activity so that nothing else can disturb their attention.

Physics is essentially curiosity about objects, and natural phenomena that cause new problems and only can solve through scientific methods included the preparation of hypotheses, the design of experiments, evaluations, measurements, and conclusions. Physics products are facts, principles, theories, and laws through the planning of scientific methods and scientific concepts in everyday life. These elements expected to emerge in the process of debriefing physics practice, so that students can experience the whole learning process, understand the natural phenomena through scientific methods and imitate the way scientists work in finding new facts. One practicum model that can access these elements is the inquiry practice model. The inquiry model emphasizes the maximum activity of students to explore and find their concepts through practical activities.

3.2.2. Benefits Aspect of Physics Practicum

The beneficial aspects of physics practicum got a positive response of benefits of practicum indicator in supporting careers the acquisition with a mean score of 2.84, and the benefits of practicum for daily life 2.91. Students generally realize that the concept of physics is very necessary and closely related to everyday life. The positive attitude shown by these students needs the design support of appropriate physics learning activities so that they can overcome the problems of physics in real life based on the physical concepts they have. However, the benefits of the physics practicum indicator to support the understanding of the concept by 2.69 got a negative response from prospective students of physics. This means that practicum activities have not been able to help them understand the concepts of physics significantly. Applied practicum design does not involve active students to investigate physical phenomena through investigative activities. For physics practicum to be more meaningful, a humanistic psychological approach can be carried out, namely to provide opportunities for students to compile and plan their experiments and control them to achieve their intended goals. Students give the task of planning, compiling, and demonstrating simple teaching aids or practicum by the subject, either alone or in groups.

The practical model that is very appropriate to provide real benefits in daily life through the application of the concept of physics is a project-based practicum model. Through project-based practical activities, students can apply physics concepts in the form of innovative physics products through predetermined work procedures. That way, students will experience first-hand that physics is very important and useful in the real world. Some of the results of the study show that a physics-based project can make student-centered physics learning activities collaborative and integrate real problems to build knowledge and creativity[11].
3.2.3. Importance Aspect of Physics Practicum Activities.

The aspect of the importance of physical practicum activities as a whole indicator evokes motivation to learn, and Practical Activities as a Scientific Approach to Learning gets a positive response from students. While indicators train basic skills in investigating, and improving skills 4 Cs (communication, collaboration, critics, and creative) get a negative response. Practical activities that are applied are only directed to support the improvement of conceptual understanding. Whereas, the skill aspect of conducting scientific inquiry, thinking skills (critical and creative) are not raised in the design and implementation of experiments. The results showed that there was a positive relationship between attitudes toward physics with science process skills [6], 21st century skills [12].

Science process skills are needed to support other skills in the 21st century. For example, digital literacy involves components such as information literacy that involve the skill of gaining access, interpreting, using and managing information; media literacy which involves the skills of analyzing media and creating media products; and technology literacy which involves the use of efficient technology and means or communication networks to reach, manage, integrate, interpret and compile information [13]. Based on this example, it is very clear that digital literacy skills need science process skills.

3.2.4. Anxiety in a physics laboratory.

Overall students feel anxious in conducting physics practicum. The attitude of anxiety that arises is anxiety using lab tools and materials, anxiety in describing graphs of experimental results, and anxiety in conducting scientific investigations. This attitude arises because they are not trained and are accustomed to conducting experiments independently such as inquiry practices. This is evident from the results of the study of the low Inquiry Skills of prospective physics teacher students in Aceh [14].

Anxiety is generated in physics practicum activities because physics practicum activities require skills such as applying theoretical knowledge in practical activities, manipulating physical variables, arranging lab tools and materials, and drawing conclusions based on safety results and measurements (Beber). The attitude of anxiety in practicum is very important to know to provide a solution to overcome it. For example, students feel anxious about using tools and materials, efforts to overcome them can be done by providing detailed instructions for using tools and materials, if possible using animation or videos so they can follow them properly.

3.2.5. The Desire to Learn Physics in the Laboratory

Aspects of desire to study in a physics laboratory indicator of confidence in physics practicum activities received a positive response from prospective students of physics. While the aspect of willingness to learn physics in the laboratory received a negative response. The willingness to learn physics in the laboratory is influenced by the classical assumption that physics learning is difficult to understand, many mathematical calculations, and many abstract concepts are found. This classic assumption, of course, will affect students' interest and motivation to take part in the physics practicum. The lack of interest and motivation of students to play an active role in learning activities will have an impact on the boredom that is generated, resulting in them no longer focusing on learning.

Laboratory lecturers or assistants are the first people responsible for determining student attitudes towards physics practice either positive or negative. Friendly lecturer personality, happy to help student’s difficulties, guide, and friendly are the main keys to create a comfortable learning atmosphere for students. Students do not have excessive anxiety in learning and feel comfortable when they are near their lecturers. The results of the study showed that students were more motivated to learn when taught by the teacher they liked that the teacher who was disliked [10]. The key determinants of student learning motivation are rewards and punishments from outside themselves. Teachers can use a variety of positive motivations for students in learning such as giving points, gifts, competitions, praise, and so on. While giving reprimand, criticism, innuendo, reproach, and punishment generally can reduce student motivation.
3.2.6. Physics Laboratory Facility
Overall the response of students of physics teacher candidates in Aceh to the availability of facilities and infrastructure to support laboratory activities is negative. The results of the observation indicate that the availability of facilities and infrastructure for practicum physics is still very limited. As a new study program, it is very reasonable if there are still many shortcomings in practical facilities and infrastructure because they are still in the development stage. Physics measuring instruments that are used also have not been supported by ICT. As a result, prospective physics students have not been able to feel the tangible benefits of ICT in practical activities. The limitations of laboratory facilities and infrastructure should not be used as an excuse for not doing practical activities. The progress of ICT in the 21st century can be used to overcome the limitations of practical facilities and infrastructure such as Phet Simulation, Video Analysis Tracker, interactive multimedia. The results of the literature review show that real and virtual practicums both have a positive impact on physics learning.

4. Conclusion
Based on the results of research and discussion of attitude toward physics laboratory, pre-service teacher physics in Aceh province showed a negative attitude, namely the indicators of interest in physics, the importance of physics practicum, physics practicum anxiety, the desire to learn physics in the laboratory, and physics practicum facilities and infrastructure. While the indicators of the benefits of physics practicum get a positive response. Negative attitudes or lack of interest in physics practicum activities are caused by the design of verification practicums that do not contribute to the increased understanding of concepts and skills in conducting scientific investigations. The results of the statistical tests showed that there were no significant differences in the attitudes of male and female student physics teacher candidates regarding practicum activities. Efforts to improve the design of physics practicums from teacher centers to become student centers that can provide tangible benefits in supporting science process skills, 4Cs skills, and problem-solving skills. It is expected that the physics study lecturers to evaluate the practicum program not only suppress the understanding of concepts, but the skills aspects of conducting scientific investigations and attitudes also need to be provided to students through practical activities.

5. References
[1] Bechmann A and Lomborg S 2013 Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge New Media Soc. 15, 5 p. 765–781.
[2] Sinaruguliyie and Mushinzimana 2016 Attitude of Physics Students towards Physics at College of Science and Technology – University of Rwanda 3, 2 p. 1–10.
[3] Veloo A Nor R and Khalid R 2015 Attitude towards physics and additional mathematics achievement towards physics achievement Int. Educ. Stud. 8, 3 p. 35–43.
[4] PISA 2015 Science Framework March p. 19–48.
[5] Sitotaw B and Tadele K 2016 Students attitudes towards physics in primary and secondary schools of Dire Dawa City administration, 2, 2 p. 14–21.
[6] Kamba A H 2018 The relationship between science process skills and student attitude toward physics in senior secondary school in Aliero metropolis African Educ. Res. J. 6, 3 p. 107–113.
[7] Barman C R et al 1995 Attitude and Motivation towards Learning Physics Int. J. Eng. Res. Technol. 2, 2 p. 1–19.
[8] Polodak K and Danforth J 2013 Attitude Towards Physics Lessons and Physical Experiments of The High School Students Eur. J. Phys. Educ. 4, 2 p. 27–31.
[9] Sakiyo J 2002 Students Attitude To Practical Laboratory Work Physics in Yola.
[10] Santrock J 2006 Educational psychology: classroom update, preparing for PRAXIS and practice (USA: McGraw-Hill)
[11] Păvăloiu I-B Petrescu I and Dragomirescu C 2015 Interdisciplinary Project-based Laboratory Works Procedia - Soc. Behav. Sci. 180, February 2016 p. 1145–1151
[12] Tuan Soh T M Arsada N M and Osman K 2010 The relationship of 21st century skills on
students’ attitude and perception towards physics Procedia - Soc. Behav. Sci. 7, C p. 546–554
[13] Aslan S 2015 Is learning by teaching effective in gaining 21st century skills? The views of pre-service science teachers Kuram ve Uygulamada Egit. Bilim. 15, 6 p. 1441–1457
[14] Saputra H Suhandi A and Setiawan A 2019 Profile of inquiry skills pre-service physics teacher in Aceh J. Phys. Conf. Ser. 1157 3

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