Pre-Service Physics Teachers’ Perception toward Hands-on Lab Activity and 21st Century Skills

D H Putri*, E Risdianto and S Sutarno
Program Studi Pendidikan Fisika, Jurusan Pendidikan Matematika dan Ilmu Pengetahuan Alam, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Bengkulu, Jl. W.R. Supratman, Kandang Limun, Bengkulu, Indonesia
*dhputri@unib.ac.id

Abstract. This study aimed to describe the hands-on lab activities and 21st century skills of pre-service physics teachers at a university in Bengkulu. The respondents of this study were 113 students who have been finished and were following the laboratory course. The research instrument was questionnaire. The explored aspects of laboratory activities were motivation, the importance of laboratory activities, equipment, laboratory activities process, suitability of curriculum, assessment, laboratory design, and the 21st century skills training. The 21st century skills explored consist of learning and innovation skills, life and careers skills, and media, information and technology skills. The data obtained will be analyzed descriptively. Based on the results of data analysis was obtained that they have a good perception toward the aspect of motivation, the importance of hands-on lab activities, and laboratory activities process; and the perception was fair for other aspects. The lowest perception score was obtained in the aspects of the 21st century skills training. This result was in accordance with the 21st century skills of pre-service physics teachers which were still in moderate category. So it is necessary to develop a model of laboratory activities design that can training and enhancing the 21st century skills for pre-service physics teachers.

1. Introduction
Higher education should do a big effort to anticipate the fast dynamical changing in education. One of the way to do it was by adapting the 21st century learning concept. The concept of 21st century learning was characterized by training and developing the 21st century skills, which were life and career skill, learning and innovation skill, and also information, media and technology skill. These skills were united as a scheme called 21st century knowledge-skills [1]. Physics learning as a part of science education has a strategic role in developing 21st century education. In physics learning, the 21st century skills could be developed by learning process in the classroom and hands-on lab activities.

Laboratory activities was an important part in the nature of science. Hands-on lab activity was the main activity in laboratory that could not be separated from physics learning. This activity could build up students motivation and achievement in physics learning, skills developing, based experimenting, practice skill developing, and has a role as a learning mode in science metodh application [2]. The right hands-on lab activity would build and reconstruct knowledge, and strenghten students comprehension of physics [3]. Furthermore, hands-on lab activity was also potential to provide higher order thinking skills [4]. However, there were many studies that found hands-on lab generally has not
gave the expected benefit. It is happens because of the many limitations and challenges faced in conducting hands-on lab activities [5].

Several studies have been conducted to explore the pre-service science teacher's responses to laboratory activities. One study result shows that pre-service science teacher’s view laboratory activities as indispensable for improving the quality of science learning. Laboratory activities are one of the tools for visualization, application, observation and experimentation related to the concepts of science studied [6]. Meanwhile, other studies show that they feel less comfortable working in laboratories, many challenges to be faced in conducting laboratory activities but nevertheless they realize that laboratory activity can not be separated from science learning. While some of the other pre-service science teacher expressed great pleasure in learning science in the laboratory and it makes the concepts more reasonable [7]. The information is useful for the development of science learning, but not enough to describe the pre-service physics teacher’s views on important aspects and challenges faced in conducting laboratory activities.

In this study, a more complete investigation was undertaken to explore the teacher’s view of laboratory activity on motivational aspects, the importance of hands-on lab activity, laboratory equipments, hands-on lab process, the suitability with curriculum, hands-on lab assessment, and hands-on lab activity design. In addition, this study aims to explore the opinion of prospective teachers related to the provision and development of 21st century skills through laboratory activities. Information regarding pre-service physics teachers’ hands-on lab activity and their 21st century skills are important to know. This can be a basic model of a design-oriented to develop 21st century skills. These skills are needed because of the global challenges of the 21st century.

2. Method
This research was a descriptive study to get the description of pre-service physics teachers’ perceptions toward hands-on lab activity and their 21st century skills in Physics Education Study Program in one of university in Bengkulu. The respondents that invaded in this study were 113 students of even semester in 2016/2017 academic year who has passed the physics hands-on lab course. At first, the questionnaire was distributed to 167 even semester students, but only 133 students (male 52 and female 81, ranging in age from 19 to 22 years) who filled and gave the questionnaire back.

The instrument used for collecting the data was a questionnaire of students perception toward hands-on lab activity and their 21st century skills. The perception scale used 5 level of agreement which were strongly disagree, disagree, less agree, agree, and strongly agree. The questionnaire used in this research has been through the validity and reliability test. The students’ perception data toward hands-on lab activity divided into four categories, namely miserably, poor, fair, and good. While the students’ perception data toward 21st century skills was divided into very low, low, moderate, and high.

The students’ perception questionnaire toward the hands-on lab activity consisted of 8 perception’s aspects with total 42 questions. Those aspects were hands-on lab motivation, the importance of hands-on lab activity, laboratory equipments, hands-on lab process, the suitability with curriculum, hands-on lab assessment, hands-on lab activity design, and the 21st century skills’ training. The questionnaire of students’ perception toward their 21st century skills consisted of two domain skills, which were learning and innovation skills, life and career skills, and media, information and technology skills. Each domain had several aspects of the skills.

Learning and innovation skills consist of critical thinking skills, problem solving skills, communication skills, collaborative skills, learning skills, and creativity and innovation with 33 questions. Life and career skills consists of flexibility and availability aspects, initiative and self-organizing ability, social interaction, productivity and accountability, and leadership and responsibility aspects with 27 as the total number of questions. Media, information and technology skills consist of information literacy, media literacy, and ICT literacy with 16 questions.

The raw data from questionnaire were collected, coded and tabulated to establish the analysis. Further analysis and interpretation of the data was done to obtain the description of students’
perceptions of hands-on lab activities and their 21st century skills in accordance with the domain or aspect of skills that were explored.

3. Result and Discussion

3.1. Pre-service Teachers’ Perceptions toward Hands-on Lab Activity

Based on the analysis of questionnaires data, it was found that pre-service teachers’ perceptions on hands-on lab activities were in good category for motivation aspect (A-1), the importance of hands-on lab activity (A-2), and hands-on lab process (A-4). While on the aspect of laboratory equipments (A-3), suitability with curriculum (A-5), hands-on lab assessment (A-6), hands-on lab design (A-7), and 21st century skills training (A-8), the students’ perception was in fair category. The results of data analysis is shown in figure 1.

![Figure 1](image-url)

**Figure 1.** Graph of students’ perceptions toward hands-on lab activity.

The highest score of the perception was obtained in the motivation of hands-on lab activity’s aspect that was equal to 4.48, and followed by the importance of hands-on lab activity’s aspect with 4.28. In general, the students stated that they were happy to do a hands-on lab activity, and hoping that every important concept would be supported by hands-on lab activities. They were challenged in assembling the laboratory equipments, and it was easy to learn physics through hands-on lab activities. In addition, the students believed that hands-on lab activities could improve their concept understanding, train the skills of applying scientific methods, reduce misconceptions, help to understand abstract concepts, and could train a sense of responsibility, honesty and accuracy.

The lowest perception score was obtained in the 21st century skills’ training aspect, which was 3.01, and followed by the laboratory equipments’ aspect at 3.36. In the aspect of the 21st century skills training, students stated that the hands-on lab activity has not been maximized in trained critical thinking skills, decision-making skills, creative thinking skills, problem-solving strategies, and has not yet maximized in involving computer technology to access information, analyze data, and present the results of the experiment. Furthermore, the students stated that the available laboratory equipments were not yet able to be used to explore the abstract and microscopic concepts, and it was still not fulfilled the standards need for hands-on lab activity.

3.2. Pre-service Teachers’ Perceptions toward Their 21st Century Skills

The 21st century skills explored were included the domains of learning and innovation skills (K1), life and career skills (K2), and media, information and technology skills (K3). Based on questionnaires’ data analysis, it was obtained that the results of the 21st century skills of the pre-service teachers were in moderate category with an average score was 3.62. The result of data analysis is shown in figure 2. It has seen that 21st century skills domains which were mostly comprehend by the students were life and career skills, and media information and technology skills. While the least-owned domain of
students was the learning and innovation skills. However, the final score for those three skill domains were still in moderate category.

![Graph of student's perceptions toward hands-on lab activity.](image)

**Figure 2.** Graph of students’ perceptions toward hands-on lab activity.

The domains of learning and innovation skills consisted of critical thinking skills, problem-solving skills, communication skills, collaborative skills, learning skills, and creativity and innovation. Based on the data analysis, the mean score for learning and innovation skills’ domain was 3.75 in moderate category. The data of pre-service physics teachers' perception scores on each skill in this domain is shown in table 1. The life and career skills domain consisted of flexibility and adaptability, initiative and the ability of self-management, social interaction, productivity and accountability, and leadership and responsibility aspects. Based on the results of data analysis, it was obtained that the mean score for life and career skills domains was 3.87 in moderate category. The data of pre-service physics teachers’ perception score on each skill in this domain is shown in table 2. The domain of media, information and technology skills consisted of media literacy, information literacy, and ICT literacy (information and communication technology literacy). Based on the data analysis, the mean score for media, information and technology skills domain was 3.81 in moderate category. The data of pre-service physics teachers’ perception scores on each skill in this domain is shown in table 3.

### Table 1. Score and category of learning and innovation skills

| Type of Skills                  | Items | Score | Category   |
|--------------------------------|-------|-------|------------|
| Critical thinking skills       | 5     | 3.50  | Moderate   |
| Problem-solving skills         | 6     | 3.56  | Moderate   |
| Communication skills           | 5     | 3.98  | Moderate   |
| Collaborative skills           | 5     | 4.05  | High       |
| Learning skills                | 5     | 3.85  | Moderate   |
| Creativity and innovation      | 7     | 3.55  | Moderate   |

### Table 2. Score and category of life and career skills

| Type of Skills                      | Items | Score | Category   |
|-------------------------------------|-------|-------|------------|
| Flexibility and adaptability       | 5     | 3.96  | Moderate   |
Initiative and the ability of self-direction & 7 & 3.89 & Moderate \\
Social interaction & 5 & 3.97 & Moderate \\
Productivity and accountability & 5 & 3.73 & Moderate \\
Leadership and responsibility & 5 & 3.80 & Moderate \\

| Table 3. Score and category of media, information and technology skills |
|-----------------------------------------------|
| **Type of Skills** | **Score** | **Category** |
| Media literacy | 3.84 | Moderate |
| Information literacy | 3.83 | Moderate |
| ICT literacy | 3.76 | Moderate |

3.3. Discussion
Hands-on lab is one of the important activities in physics learning. Through this activity, students can study physics through a real experience. Students can replicate how scientists study the universe using the scientific method [3]. For pre-service teacher, hands-on lab activity was not only help them in constructing and reconstructing the concepts of physics, but also as a moderate to understand the nature of physics which consists of product and process domains. These experiences may encourage them to teach physics in a right way to the students. Many benefits of laboratory activity in learning physics encouraged researchers to develop the best way of doing hands-on lab activity [8]. The development of laboratory activity could be based on the main objectives of the learning, the activity design, the students’ prior knowledge and experience, the contextual phenomenon, and based on the type of media used. Information related to the perception of pre-service physics teacher toward hands-on lab activities and their early profile of 21st century skills becomes important to know. These information was required as a reference in formulating every aspects of hands-on lab design which would be developed.

This research explored the perception of pre-service physics teacher toward hands-on physics lab activities and their 21st century skills at a university in Bengkulu, Indonesia. The result of data analysis showed that the students’ perception toward hands-on lab activity that has been done was in moderate category. Student perceptions of 21st century skills were also still in the same category. If it was reviewed on every aspects of student’s perception toward hands-on lab activities, it was only the aspect of hands-on lab motivation, the importance of hands-on lab activities, and the hands-on lab process which were got good category responses. While the student’s perception of the other aspects on hands-on lab activities were in moderate category. Based on these results, it was known that generally students have high motivation in following the hands-on lab activities. Students agreed that the hands-on lab is an important activity that is very useful in learning physics. Nevertheless, the results of perceptual data analysis indicated that the laboratory equipments used for hands-on lab activity were still not reached minimal standard of the subject needs, especially for an abstract and microscopic concepts. This was reinforced by the statement that the hands-on lab activities that has been done was in accordance with the objectives of the curriculum but was not able to reach all the main concepts, especially the complex and abstract concepts.

According to the students’ perception, hands-on lab activities have been done in a good process, but still in conventional way. Conventional for laboratory activities were characterized by hands-on lab procedures that have been prepared in detail on manual guideline, the unvaried laboratory model, the routine problem’s explored, the assessment focused on the lab report and exam, and the lack of ICT technology used in the lab. The results were based on the data analysis of students’ perception which showed that as many as 60.2% of the students were less agree on the item which stated that hands-on lab activities has been done in order to train the problem-solving strategy on the real problem than to verify the theory's truth. This means that the laboratory activity is intended to verify and reinforce the material already given in the classroom. Explicitly these results indicate that physics lab activity is generally still done conventionally. This result is consistent with several findings in
previous studies [8]. Conventional laboratory activities generally emphasize motor activity rather than metacognition [9] so that it is less able to train high-order thinking [10].

Furthermore as many as 63.7% of students were less agree on the item that stated hands-on lab activity begins by giving contextual problem related to daily life and the solution will be investigated through hands-on lab activity, 67.3% students stated that they were less agree that hands-on lab activities contain the activities of formulating hypothesis and then testing it through observation test, measurement, and data analysis which the procedure was determined by the students themselves, and as 54.9% students were less agree to the item which stated that the hands-on lab activity used a various model. In addition, as many as 82.3% of the students were less agree on the item that said the hands-on lab assessment was mostly prioritized on the science process aspect rather than the hands-on lab report and the test, and as many as 62% of students were less agree on the item which stated that the hands-on lab activity has conducted to encourage the use of computers to organize data, analyze data, and write laboratory reports.

The hands-on lab activity has not been maximal in training and providing 21st century skills. This result was seen from the score of 21st century skills’ training aspect through the hands-on lab activity which was in the lowest order (Figure 1). This fact was in line with the analysis results of the 21st century skills’ perception questionnaire which showed that students 21st century skills were still in the moderate category (table 1, table 2, and table 3). These results were also in line with the previous research, found that the critical thinking and scientific reasoning of pre-service physics teacher at a university in Bengkulu were at low and moderate levels [11].

Based on the explanation above, it can be summarized into some important points such as students have good motivation in the hands-on lab activity, students stated that the hands-on lab activity was very important to do in physics learning, abstract and microscopic concepts could not be explored due to the limitations of laboratory equipments, hands-on lab activity was still done in conventional way, the hands-on lab activity has not maximally provided 21st century skills, and students 21st century skills were still in moderate category. This result could be used as a reference in the development a model of laboratory design which would be used as an alternative solution to various problems obtained.

4. Conclusion
Based on the research results and discussion, it can be conclude that hands-on lab activities that has been done at a university in Bengkulu were in fair category. Students gave the highest perception score on hands-on lab motivation and the importance of hands-on lab activity aspects. While the lowest score was given to the aspects of students 21st century skills’ training and laboratory equipments. The 21st century skills of pre-service physics teacher at a university in Bengkulu were in moderate category. The lowest to the highest scores of 21st century skills was gained on the domains of learning and innovation skills; media, information and technology skills; and life and career skills. The results of this study indicated the importance of developing 21st century skills-based laboratory design model.

Acknowledgments
The research was funded by the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia through the Applied Product Research scheme at University of Bengkulu. The research team expressed gratitude for all the facilities provided.

References
[1] Trilling B and Fadel C 2009 21st Century Skills: Learning for Life in Our Times (San Francisco: Jossey-Bass A Wiley Imprint)
[2] Hofstein A and Lunetta V N 2004 Science Education 88 pp 28-54
[3] Tobin K 1990 School Science and Mathematics 90(5) pp 403–18
[4] Deacon C and Hajek A 2010 International Journal of Science Education pp 1–35
[5] Fuccia D, Witteck T, Markic S and Eilks I 2012 Trends in Practical Work in German Science Education
[6] Harman G, Cokelez A, Dal B and Alper U 2016 Universal Journal of Educational Research 4(1) pp 12-25.
[7] Akarsu B 2015 Journal of European Education 5(2) pp 56-61.
[8] Malik A and Setiawan A 2016 The development of higher order thinking laboratory to improve transferable skills of students. International Conference on Innovation in Engineering and Vocational Education (Indonesia: Bandung)
[9] Hodson D 1990 School Science Review 71(1) pp 33–40
[10] Heller K and Heller P 2010 Problem Solving Labs, In Cooperative Group Problem Solving In Physics A: user’s Manual (United State: Departement of Physics University of Minnesota).
[11] Sutarno, Setiawan A and Kaniawati I 2016 Keterampilan berpikir kritis dan penalaran ilmiah mahasiswa calon guru fisika: field study pada salah satu LPTK di Kota Bengkulu Prosiding Seminar Nasional Pendidikan Dasar dan MIPA pp 111-22 (Indonesia: Bandung)