Pre-service teacher ideas about designing demonstration set in physics education program

Susilawati1,*, C Huda1, Masturi2, S P Saputro3 and N Khoiri1

1Department of Physics Education, Universitas PGRI Semarang, Semarang, Indonesia
2Physics Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Indonesia
3Department of Pancasila and Citizenship Education, Universitas PGRI Semarang, Semarang, Indonesia

*Corresponding author: susilawati.physics@gmail.com

Abstract. This study aims to explain the idea of pre-service teachers about designing demonstrations used by teachers when the process of physics learning is simple. Research sample on 25 pre-service physics teacher. The research method is the descriptive method. The research instrument uses an observation sheet and interview format. Observations indicate that 51% of pre-service teachers can design demonstrations through analysis of laboratory activities in schools to obtain demonstration ideas, 34% of potential teachers can design demonstrations through project tasks and 37% depending on initial knowledge about demonstrations. Student ideas include low category and frequency level through literature studies of physical content, literature studies on experiments, natural phenomena and daily life experiences. These results imply that instruction in physics lab studies leads pre-service teachers to have a more scientific understanding of designing demonstrations.

1. Introduction

Physical learning is designed using science ideas that are physics-based teaching materials of demonstration and scientific experiments [1]. The results of the interviews of field practitioners' field teachers suggest that physics learning does not use science ideas, students focus on remembering facts without sufficient support to engage directly physically and mentally in physics learning. Potentials that need to be developed for science learning are scientific and practical, the concept of crosscutting and the idea of discipline. The emphasis is on student participation in investigations designed for mastery of physical content and practice. The integration of the mastery of content and the practice of physics requires a scientific idea to be grown in learning.

The result of early observation of physics learning needs in schools is an activity that was learning students to independent, creative and mastery of the concept. Some of the shortcomings of practical physics learning as a formula, less use of tools and limited availability of facilities, infrastructure, and learning resources. From the material aspects of physics that the proposition of physics confirms a hypothesis assisted by mathematics in the form of rules that condition the form of the statement. Physical material shows facts that can confirm or disprove [2]. This characteristic expects students to perform scientific activities in the form of manipulation of the real things [3].

In today's scientific education condition, it is necessary to have high-quality human resources with expertise, able to work together, think high level, creative, skilled, able to communicate, and able to
learn. Simple physics demonstrations such as pulling table quickly without affecting the glassware on it compared to when the stuff on the tablecloth is a ball [4]. Another demonstration, demonstration of standing waves that provides an understanding of the concept that the interaction between the electric field and magnetic field and the phenomenon of resonance. It can also serve as a good demonstration with the aim of improving skills and teaching materials effectively [5,6].

If there are equipment and technical limitations when performing demonstrations, the use of different techniques is recommended such as simulations, eg, experiments related to plasma state are very difficult in class due to technical limitations [7]. Demonstration activities can train the expected Collaborative Skills and Technological Skills already given to Senior High School students [8]. Development of demonstration package can be done by physics teacher candidate because laboratory lecture program gives the opportunity to physics teacher candidate to design physics experiment based on technology [9]. The ability of physician candidates in the design of practical activities continues to be improved [10]. Excavation of candidate physics teacher ideas in This lesson is specific to materials that require media or experimental demonstrations. Steps that can be done include competence information, presentation of the material overview, dividing the task of discussing the materials for each group, appointing the students or groups to demonstrate their sections, class discussions, conclusions, and evaluations.

In this regard, the ideas of pre-service teachers on student demonstration set have implications for studying the understanding of the physics concept of physics. Also, real demonstrations to provide real observations do not get a good response from students because demonstrations can be taken from the internet. This study focuses on how pre-service teachers plan and conduct simple demonstrations. Also, how the student response to the analysis and interpretation of demonstration data. Ideas and opportunities for pre-service teachers learn through designing a demonstration of physics to demonstrate the practice of science to students. This pre-service physics teacher's experience in planning and executing scientific activities with measurement variations influences pre-service teachers to have the ability to expose physics demonstration activities.

The results of interviews indicate the dominant physics teacher candidate uses reasoning about how the observations reveal the real conditions of the school. The variation of scientific idea search through the exploration of the development of physics props has not emerged because of the lack of demonstrations that can be used. The activity that is done by physics teacher candidate is the investigation, and this category is more than just observation and space exploration. Investigations are conducted through several stages of observation supported by reasoning and inference. The investigation is a sophisticated idea rather than simply done by describing observations. This extends the understanding of concepts because more often the ideas are partially correct to what our team considers to be expert understanding. The ability of inference in developing ideas are examples of potential physics teachers providing details on how certain observations will provide evidence that can be used to conclude demonstration packets.

2. Methods
This research is part of an empirical study on physics lab study by a pre-service physics teacher. The sample was chosen by purposive sampling, 25 physics teachers were trained to develop physics concept demonstration package. This research method using a descriptive method [11]. The research instrument uses observation sheets and interviews [12]. Observation sheets for measuring ideas and creations in the process of designing a student physics demonstration package interview to collect information about idea search and realization of teacher candidate idea to complete set demonstration. The technique of collecting data with observation to the activity of physics teacher candidate in discussion to realize the creative idea in the form of designing demonstration set. Interview with pre-service teachers about the idea that will be developed into a packaged product of physics experiment. The technique of data analysis using descriptive quantitative data analysis for data of observation result and descriptive qualitative data analysis for interview result data.
3. Result and Discussion
In this section, the results of the study describe the categories used to encode students' ideas about designing a pre-service physics teacher demonstration set.

3.1 Results of Observation Sheet
The categories used to organize student ideas and frequency of response students are presented in Table 1.

| Category                                                                 | Frequency |
|--------------------------------------------------------------------------|-----------|
| Analyze laboratory activities at school to get demonstration ideas        | 51%       |
| Project tasks to design demonstrations                                    | 34%       |
| Early knowledge of pre-service physics teachers about demonstrations      | 37%       |
| Studies of literature on physical content                                | 9%        |
| A study of literature on experiments                                      | 11%       |
| Natural phenomena                                                         | 5%        |
| Experience everyday life                                                  | 17%       |

The level of categories and frequency of student ideas that are categorized as high enough in designing demonstration set through the analysis of laboratory activities in schools, and the project task of designing demonstrations. Low category and frequency levels include literature studies of physical content, literature studies on experiments, natural phenomena and daily life experiences.

3.2 Results of Interview
The observable general pattern of student responses based on interview results is presented in Table 2.

| Aspect            | Frequency                                                                 |
|-------------------|---------------------------------------------------------------------------|
| Material          | Tools and materials for making demonstration packs made of plastics, wood and metals, materials readily available in the surrounding environment, and easily formed materials by the objectives of the demonstration set design |
| Timeline          | The fastest time is 2 months and the maximum 4 months consists of the demands of the demonstration package needs, the idea of making, designing, planning, making demonstration set and demonstration test |
| Place             | Plans for packet-making activities are carried out in laboratories, workshops, and simple production houses |
| Topic             | Topics selected mechanics, electricity and measuring instruments          |
| Design            | The first designs are designed in the form of a demonstration set framework and final design in the form of applications that can be added |
| Trial             | Testing is done at most three times and at least 2 times the initial test of the design of the demonstration package, further testing after repair and testing to refinement the demonstration set |
| Data              | Quantitative data of demonstration result and qualitative data as supporting of discussion and concept |
| Product           | A demonstration package of at least one variation of the demonstration display and at most 4 variations of the demonstration display |
The results of physician interviews about the idea of designing a demonstration set are material and timeline. The material is very much consideration regarding the difficulty of finding material that suits the purpose of the design of the demonstration set. The timeline is highly considered because the design of the demonstration package must go through several stages to be done scientifically to present the physical material content properly and thoroughly. The results of the interviews provide information that the idea of pre-service teachers is very varied and extraordinary. However, these students’ ideas lack adequate facilities due to the limited technical personnel, equipment and time of manufacture.

Demonstration methods stand out as an effective method in presenting content reinforcement of physics concepts, conceptual understanding, and conceptual analysis [13]. The integrated learning experience of demonstration and direct learning provides a learning process and interactive learning [14]. Students with kinesthetic learning styles are aptly taught by demonstrations involving kinesthetic students. The conformity of the method with the learning style of the student is very important for the achievement of the maximum learning achievement. Information and communication technologies are evolving as an effective means of shaping the creative potential of pre-service physics teachers.

The professional development process of teachers pays great attention to the development of information and communication technology bases to use them in physics learning [15]. Conceptual understanding and student attitudes toward physics can be given through demonstrations [16]. In everyday learning practice, it is necessary to demonstrate the measuring instruments in the classroom. Demonstrations present teachers with the opportunity to introduce physics to explain a variety of physics content simply [17,18]. This activity is technical and creative. The results of a bottle study sing in a higher and lower tone as a form of energy that is raised and enhanced by variations in tension levels. Students will be fascinated by this fun and skillful illustration of the concept of resonance [19, 20]. Demonstration of physical phenomena through simple devices and simple toys provides meaningful pedagogical. The pre-service teacher's experience got the idea of designing a school student demonstration set using scientific equipment.

The results of the investigation have not been found by physics candidates to expose their ideas through experiments. However, pre-service teachers emphasize how involvement in scientific practice through observation. The category level and frequency of student ideas that are categorized as high enough in designing demonstration set are through the analysis of laboratory activities in schools, and the project task of designing demonstrations. Low category and frequency levels include literature studies of physical content, literature studies on experiments, natural phenomena and daily life experiences. Students make it possible to explore more concepts through demonstrations.

Characteristics of physics teacher-oriented ideas are based on observation, though, and literature review. Various observations made by physics teacher candidate in exploring information on laboratory limitations for the implementation of demonstration. Student often portrays the correct scientific ideas on how to design an interesting and easy physics demonstration. There are students who demonstrate a more sophisticated understanding of the demonstration of the concept of physics. Nearly half the number of classes indicates the need for observation as an analysis of the need for demonstration packs at schools.

4. Conclusion
This research can explain the idea of teacher candidate to design a demonstration package that can be used by the teacher when the process of physics was learning in the classroom and the laboratory. Observations indicate that 51% of pre-service teachers can design demonstrations through analysis of laboratory activities in schools to get demonstration ideas, 34% of pre-service teachers can design demonstrations through project tasks and 37% rely on preliminary knowledge of demonstrations. Low category and frequency categories include literature studies of physical content, literature studies on experiments, natural phenomena and daily life experiences. The results of physics interviews about the idea of designing a demonstration package are related to material selection and timeline considerations. The material is very much consideration regarding the difficulty of finding material
that suits the purpose of the design of demonstration set. The timeline is highly considered because the design of the demonstration set must go through several stages that must be done scientifically to present the content of physics material. The results of the interviews provide information that the idea of pre-service teachers is very varied and extraordinary. However, these students' ideas lack adequate facilities due to the limited technical personnel, equipment and time of manufacture. Recommendations obtained that the physics lab course leads pre-service teachers to have an understanding of scientific concepts in designing a demonstration as an activity that can give students mastery of the concept of cognitive and psychomotor performance skills. Also, effective aspects that can be integrated into demonstration activities are the concentration of learning, thorough and objective.

Acknowledgment
We thank Research, Technology and Higher Education of Indonesia for financial support via LLPM Universitas PGRI Semarang, Indonesia.

References
[1] National Research Council 2012 A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and CoreIdea (Washington DC: National Academies Press)
[2] Bitbol M 2018 Mathematical Demonstration and Experimental Activity: a Wittgensteinian Philosophy of Physics (France: Centre National de la Recherche Scientifique)
[3] Akinbobola and Olufunminiyi A 2015 J Educ Pract 6 27
[4] Cross R 2016 Phys Teach 54 37
[5] Tsutsumanova G and Russev S 2013 Eur J Phys Educ 4 1
[6] Ajaja P O 2013 Int Educ Stud 6 63
[7] Korkmaz S D, Aybek E C and Pat S 2015 Univers J Educ Res 3 735
[8] Susilawati, Ardhyanis, Masturi, Wijayanto and Khoiri N 2017 J Phys: Conf Ser 824 012010
[9] Susilawati, Huda C, Kurniawan W, Masturi and Khoiri N 2018 J Phys: Conf Ser 983 012045
[10] Susilawati, Wijayanto, Khoiri N, Masturi and Xaphakdy S 2018 J Pendidikan IPA Indonesia 7 122
[11] Creswell J W 2015 Educational Research, Planning, Conducting and Evaluating Quantitative and Qualitative 5th (Boston: Pearson Education)
[12] Fraenkel J R and Wallen N E 2007 How to Design and Evaluate Research In Education 2nd ed (New York: McGraw Hill)
[13] Deborah O 2015 J Educ Pract 6 14
[14] Huynh T, Hou G and Wang J 2016 Am J Eng Educ 7 37
[15] Ramankulova S, Usembaevaa I, Berdia D, Omarova B, Baimukhanbetova B and Shektibayeva N 2016 Int J Environl Sci Educ 11 9598
[16] Faour M A and Ayoubi Z 2018 J Educ Sci Environ Health 4 54
[17] Kubinová S and Šlég r J 2015 Phys Educ 50 472
[18] Michaelis M M 2014 Phys Educ 49 67
[19] Ruiz M J and Boysen E 2017 Phys Educ 52 1
[20] Shakerin S 2018 Phys Teach 56 248