High school Physics teachers' perceptions of the learning revolution era 4.0 at training activities in Bener Meriah Regency

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Abstract. The constraints of the limited practicum facilities for Physics lessons in Bener Meriah Regency High School can be overcome by virtual laboratory practicum. Learning technology using a virtual laboratory experiment method based on Smart Phone is given to Physics teachers in the district so that they can use simple information technology applications in learning. The subject matter of physics used in this training was Waves and Optics. This activity is gradually carried out to pioneer the realization of physics learning in high schools following the demands of the industrial era 4.0. The output is expected to improve the pedagogical quality of teachers, the learning process, and to overcome the limitations of Physics practicum tools, and to support online learning during the Covid-19 pandemic. The activity was attended by 10 high school teachers in Bener Meriah Regency. All participants were able to master the transfer of technology provided. They are optimistic that this IT technology can be implemented in the learning of Wave and Optical material Physics in their schools on duty. 100% of trainees are satisfied with the service and expect will be any similar activities to be continued for other Physics materials.

1. Introduction

Physics is one of the main subjects learned at the senior high school level. Learning material is the disclosure of natural phenomena obtained through practicum and mathematics. Therefore, learning concepts through practicum facilitates and expands students' literacy skills [1]. The experimental method in the learning process can improve students' absorption and analysis of concepts because they can build their knowledge based on their learning experiences [2]. However, the practicum facilities owned by schools in Aceh province, especially in Bener Meriah District, are not yet available in sufficient numbers so that teachers often do demonstrations in the classroom than practicum in the laboratory [3]. In general, the available practicum tools for kinematics, electricity, and optics are adequate although not complete [4,5], but for other materials such as waves, they are not yet available. Today, the development of technology entered the 4.0 era where smartphones have become objects that are commonly used by all people from various backgrounds, from adults to children under 5 years old who are accustomed to using smartphones in their daily lives. The openness of society to the use of smartphones allows it to be used in learning, especially in higher education [6]. To overcome the shortage of practicum facilities, one solution that can be done is to carry out physics learning by using a smartphone. Currently, there are many learning applications that we can find on the google play store for smartphones that use the Android operating system [7] including applications that allow for virtual lab work. Therefore, learning physics material with the virtual laboratory practicum method is very possible to be carried out in high schools in the current 4.0 revolution era [8]. Before this learning is applied to students, teachers as learning facilitators in schools...
must first master this method. Training or technology transfer to teachers to apply it in learning in schools needs to be done as a solution to overcome the problems faced [9], as well as to increase the professional competence and creativity of teachers [10].

Based on the description above, training to apply virtual laboratory methods with smartphones in physics learning is very important to be carried out for physics teachers in Aceh, especially in Bener Meriah District to improve teacher professionalism and become a solution to the limited practical tools in Bener Meriah. The transfer of learning technology for Physics materials using the virtual laboratory practicum method with a Smartphone is planned to be carried out in stages for physics teachers in Aceh province. Activities in 2020 will be focused on Benar Meriah Regency. The location of activities is determined based on the results of initial observations. The information obtained is:

1. The laboratory practicum facilities in the Bener Meriah district are lacking. Physics laboratories in particular are not yet available in senior high school. The practicum facilities only available are science. So, the Physics practicum is carried out in an integrated science laboratory, making it difficult for teachers to divide their activity time.
2. The available infrastructure of practicum tools is very limited. Practicum can only be done for basic physics materials (classical mechanics).
3. Physics teachers at the senior high school in Bener Meriah district have not mastered the virtual laboratory practicum method for Physics learning activities.
4. There has been cooperation between lecturers in the Department of Physics Education, FKIP Unsyiah, and the Association of Physics Teachers (MGMP) in the Bener Meriah district.

The objectives of the activity are:
1. Improving the quality of physics subject teachers in Bener Meriah Senior High Schools in mastering and implementing Physics learning using the Virtual Laboratory practicum method.
2. Facilitating the implementation of physics lessons in Bener Meriah Senior High Schools using the virtual experimental method
3. Optimizing the facilities and technology available for the implementation of pursuit according to the technological demands of the 4.0 revolution era
4. Training the skills of mastering physics learning with the virtual experimental method, as a pilot project, the Wave material was selected. It is hoped that other physics materials can be developed by participants in a self-directed manner.
5. Increase students' understanding of Bener Meriah Senior High Schools of physics subject matter.

The benefits of the activity are expected to improve the quality of physics learning at senior high schools in the Bener Meriah district. In the long term, it is expected to contribute to improving the quality of education in Bener Meriah.

2. Method

The experimental learning method using virtual laboratory media was trained to physics teachers in Bener Meriah. Technology transfer is carried out by training methods. The implementation of activities is equipped with learning materials such as modules, worksheet, and evaluation form. The modules and worksheet that have been prepared are directly trained/practiced by the teacher (training participants) during the activity. The training activity provided is expected to make it easier for teachers to understand the application of experimental methods assisted by virtual laboratory media using smartphones for learning physics, especially wave material. The first activity is to introduce a virtual practicum application found on the Google Play Store on Smartphone that use the Android operating system. After the physics teachers were able to download and run the software, activities were continued to use it in the physics learning process (Figure 1). The activity topic is limited to Light Intensity material. During the activity, an observation of the state of implementation is made. Teachers who are experiencing difficulties are given direct assistance. After the activity took place a written interview was carried out using a questionnaire. Four alternative answers are given for each question. Each answer is scored as follows: 4 = strongly agree; 3 = agree; 2 = disagree; and 1 = strongly disagree. After all the test result data is collected, then an analysis
of teacher responses is carried out to determine the teacher's perceptions of the instructor's ability and the updating of information/training benefits with the formula:

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P = \frac{\text{the total score of each question}}{\text{maximum score}} \times 100\% \tag{1}
\]

Furthermore, a recapitulation of the percentage of teacher perceptions of the training is carried out and then the criteria for teacher perceptions are determined based on the Table 1 [11].

**Table 1.** Table of score and criteria from questionnaire

| No. | Percentage (%) | Criteria  |
|-----|----------------|-----------|
| 1   | 86-100         | Very good |
| 2   | 76-85          | Good      |
| 3   | 60-75          | Enough    |
| 4   | 55-59          | Less      |
| 5   | ≤ 54           | Very Less |

The following describes in detail the steps for the training activities carried out in Bener Meriah Regency:

![Figure 1. The procedure of Training Activities](image)

**3. Result and Discussion**

Independent Community Engagement Program, this 2020 activity was attended by 10 high school physics teachers in Bener Meriah. The results of the activities and their discussion are described in the following description.

**3.1. Implementation of activity**

The training took place according to the plan. The weather is sunny at the time of the activity. The training venue is selected outdoors. Physics teachers in the Bener Meriah district took the activity seriously (Figure 2). All teachers participating in the activity listen to and follow directions from the instructor.
Figure 2. The implementation of the learning technology transfer activity of Physics material assisted by the virtual laboratory practicum method using a smartphone

The atmosphere of the activity looked fun and the meeting took place very intimately. There is a longing between the participants and the instructor. This is because, generally the activity participants are alumni of the Physics Education Department, FKIP Unsyiah and the instructors are lecturers in the department. Other benefits obtained from this training are to establish a better relationship between alumni and the alma mater.

Table 2. The perception of the physics teachers of Bener Meriah on the ability of instructors in the training physics material in accordance with the development of the revolution 4.0 era.

| No. | Statements                                                                 | Score |
|-----|-----------------------------------------------------------------------------|-------|
| 1   | Instructor can coordinate and condition situations in order to prepare all training participants to start activities | 100   |
| 2   | Instructor can motivate participants                                         | 100   |
| 3   | Instructor were polite                                                       | 100   |
| 4   | Instructor use good, simple, and easy to understand the language             | 100   |
| 5   | Instructor provide sufficient guidance to all participants in the activity of virtual experiments, discussions, and questions and answers | 95    |
| 6   | The guidance provided by the Instructor is easy to understand                | 100   |
| 7   | Instructor master all materials                                              | 85    |
| 8   | Instructor can use time efficiently                                         | 77.5  |
| 9   | The instructor relates the concept to real conditions in everyday life       | 77.5  |
| 10  | Instructor can inspire participants to improve and increase their professionalism in carrying out their duties | 87.5  |
|     | **Total**                                                                   | **92.23** |

3.2. Perceptions of physics teacher in the training on instructor ability

The ability of instructors to carry out training activities was obtained based on the perceptions of the Physics Teachers who participated in the training (Table 2). Based on the evaluation questionnaire, it was found that the instructor's ability in implementing activities ranged from 77.5 to 100. Based on the criteria in Table 1, the instructor's ability was good to very good. The instructor's ability is supported by mastery of the material, his teaching experience, and training materials such as modules and the prepared worksheet. The training materials prepared are simple and easy to apply, as a result, the implementation of the activities is
interesting and takes place in a pleasant situation because participants can build their competence in a dynamic way [12]. The training approach strategy carried out by the instructor was impressive, causing the training participants to look active. Observations during the activity took place, participants were very enthusiastic about following the instructions from the instructor. This cannot be separated from the instructor's ability to motivate participants to have the desire to develop their competencies. Because in a learning process, motivation greatly affects the results achieved. If the participant has high motivation and the instructor delivered the material with the right method, the results will also be maximized [13]. Module and worksheet are important things and are very much needed in carrying out both conventional and virtual practicum. In learning using this virtual practicum method, modules and worksheet can improve science process skills so that learning is more interesting and useful [14]. Based on participants' perceptions and observations during the activity, the learning implementation materials (modules and worksheet) using the virtual laboratory practicum method using a Smartphone are good enough and can be used for other activities.

3.3. Recency of information and benefits
The recency of information and benefits from the training of physics learning using the virtual laboratory practicum method was obtained based on the perceptions of the participants through a questionnaire (Table 3). All activity participants stated that the material presented in this activity was the latest information. Therefore, this activity will provide a lot of additional knowledge and skills to them. The scores obtained from the participants' questionnaire answers ranged from 97.5 to 100. Based on the criteria in Table 1, this activity is very useful in providing additional knowledge to participants. 100% of the participants believed that they could use this additional knowledge in catch-up activities in the schools they served. Thus, the pedagogical abilities of the participating teachers can be improved.

Table 3. Teachers' perceptions of the recency of information and the benefits of training

| No. | Statements                                                                 | Score |
|-----|-----------------------------------------------------------------------------|-------|
| 1.  | The use of animation media using a smart phone application is the first time I know from this training | 100   |
| 2.  | I gained a lot of additional knowledge and skills related to the Smartphone application in learning Physics | 95    |
| 3.  | I believe these skills can be used in learning at the school where I work   | 100   |
| 4.  | I believe these skills enrich classroom learning methods                    | 100   |
| 5.  | I believe this application can overcome the limitations of the real laboratory Physics practicum facilities in my school. | 100   |
| 6.  | I am sure of the lab. Virtual can overcome the difficulties of students understanding physics material in textbooks at school. | 97.5  |
| 7.  | I believe these skills can increase my professionalism.                    | 97.5  |
|     | **Total**                                                                   | **98.57** |

All the participating teachers stated that they could apply virtual laboratory methods to learning skills in the schools where they served. This is because learning with the virtual experimental method is very interesting and is able to explain physics concepts in detail so that it can help improve students' understanding of concepts [15]. In addition, IT applications in learning are something new for high school students in the Bener Meriah and make it easier for students to learn to use virtual content anywhere [16], thus the learning process becomes more interesting and fun. The use of smartphones as a learning medium is not an obstacle. In general, students already have and are used to using it. This information is very encouraging to the implementation team. This is because the main objective of this activity is to improve the pedagogical skills of physics teachers. The knowledge and skills acquired will improve the physics learning process in schools. The learning process, which is dominated by conventional models, will
gradually change to use active learning models. The lecture method will slowly change to the virtual experimental method because it is proven to increase student achievement [17]. So, the limitations of practicum facilities for physics lessons can be overcome with a virtual laboratory. Improvements in the learning process will improve learning outcomes [18]. In the long term, it is hoped that the members will benefit from improving the quality of education, especially physics lessons in Bener Meriah district.

4. Follow-up Plan

Based on the suggestions and input from the participants, almost all the materials from the subject matter of physics lessons are not yet available practical tools in their schools. Therefore, they expect the training to be carried out for all Physics subject matter in high school. In terms of the purpose of this training activity, it is to provide a pilot project that can open the horizons of physics teachers to be able to independently develop other materials. The follow-up to this training is to carry out a similar activity that is planned to be carried out for high school physics teachers in other districts in Aceh province. Thus there will be acceleration and equalization of mastery of the Physics learning method using a virtual laboratory. Mastery of this method becomes urgent during online learning during the Covid-19 pandemic where teachers have a very important role in determining the right strategy for the effectiveness of the learning process [19].

5. Conclusion

High school physics teachers give a good appreciation to the implementation of IT technology transfer activities in physics learning. The instructor's ability to train and the supporting devices used were considered good. This activity provides additional knowledge and skills to high school physics teachers in the Bener Meriah district in mastering virtual laboratory practicum technology. The skills they acquire can be applied in pursuits where they serve. It is believed that virtual laboratory practicum can be implemented. In accordance with the progress in the industrial era 4.0, almost all high school students in Bener Meriah district have owned and used a smartphone communication device. In addition, the virtual experimental method greatly helped the implementation of online learning during the Covid-19 pandemic. Therefore, they are optimistic that learning Physics using the virtual laboratory lab method will not experience obstacles. Their skills improve the pedagogical abilities and professionalism of teachers. Improvements in the learning process will improve students' understanding of physics material. In the long term, it will improve the quality of high school graduates in the Bener Meriah district.

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