DIMAS: Jurnal Pemikiran Agama dan Pemberdayaan
Volume 23 Nomor 2, October 2023
DOI: 10.21580/dms.2023.232.14403

Improving the Teachers Skills in Semarang City and Surrounding Areas in Using PhET Simulations Application-Based Virtual Laboratories

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Abstract:

The practicum learning process transformed from offline to online during the pandemic. Teachers must have the skills to use virtual laboratory applications to improve the learning process. Community service activities have been carried out in the form of virtual laboratory training to improve the skills of junior-senior high school teachers based on the PhET Simulations application in the city of Semarang and surrounding areas. Evaluation of training activities using the self-assessment questionnaire method before and after the participants attended the training. The questionnaire comprises four aspects of ability: the ability to access the virtual practicum application, use the PhET application via a browser, download simulations on the PhET Simulations application, and use the PhET Simulation application as a means of physics practicum. Based on the analysis of the n-gain test, the results of increasing competence were 32% of participants included in the high category, 30% of participants included in the medium category, and 38% of participants included in the low category.

Keywords: *PhET Simulation, n-gain, Teacher Skills, Virtual Laboratory, Physics Practicum.*

Introduction

Practicum is a learning activity that can be carried out so that students can discover, investigate, collaborate, think critically, communicate and be able to solve problems (Tai et al. 2022). Apart from that, practicum is a learning process that can improve student achievement (Qomariyah et al. 2019). However, the physics practicum in Junior and Senior High Schools was done differently than expected. The issue of limited facilities and infrastructure is one of the obstacles for teachers in carrying out physics practicum. Limited facilities, such as the availability of laboratory equipment in the form of a physics kit and very limited learning media, require schools to utilize Information Communication Technology (ICT) (Sujanem et.al, 2019). The next obstacle is limited infrastructure, such as a laboratory room that doubles as a classroom, so practicum equipment tends to be damaged (Sujanem et.al, 2019). Thus it is necessary to increase facilities and infrastructure that can support the use of ICT (Nuryantini and Yudhiantara, 2019). The pandemic due to the Covid-19 virus has also become a factor in the obstacles; the online learning process has become a solution for home learning (Herliandry et al. 2020). Teachers are required to adapt to online learning by utilizing technology like face-to-face learning in class (Nurpratiwi et al. 2021).

Virtual laboratories can replace real laboratories in conducting and can be applied by teachers as a support in developing and helping students to understand physical phenomena in science learning (Riantoni, Astalini, and Darmaji 2019). The application of this hyper-realistic virtual laboratory shows that students who use it achieve better learning achievements than students who use traditional simulations or real laboratories (Martínez et al. 2011). Apart from that, the implementation of virtual laboratories can also collaborate with the Unity of Science to produce students who are able to communicate knowledge with reality in a comprehensive manner (Fahmi 2019). One of the virtual laboratory applications that can be used easily and for free is the PhET Simulation application. The use of this application can increase students' understanding of physics, and the virtual practicum learning process takes place interactively (Adam et al., 2020; Adams et al., 2006; Angraini et al., 2019; Bhakti et al., 2019; Sartika et al., 2020;

Wieman et al., 2010). In the PhET Simulation application, some physical conceptual models can help students get to know new topics, build concepts or skills, strengthen ideas, provide final results and reflections, and provide standard visualizations between students and teachers (Riantoni, Astalini, and Darmaji 2019).

Lack of teacher skills in virtual laboratory applications results in virtual practicums not being implemented (Sartika et al, 2020). Even though the teacher has a role as a guide, director, motivator, supervisor, designer, and implementer (Imron and Shobirin 2021), so increasing teacher skills to support the learning process is essential. Research conducted by Nuryantini and Yudhiantara (2019) shows that teachers have yet to make much use of mobile applications as tools for physics experiments. This condition occurs because of their limited knowledge of using mobile applications as tools for physics experiments. Based on a survey of 24 Senior-Junior High school teachers in the city of Semarang and its surroundings, 58% of teachers said they had never used PhET Simulations, and 42% of other teachers said they had used PhET Simulations. Training to improve teacher skills in using virtual laboratories to support an optimal physics learning process (Setya Putri et al. 2021). Based on the description of the problems that have been mentioned, community service activities are needed in the form of training to improve the skills of Senior-Junior High school teachers in using a virtual laboratory based on the PhET Simulations application in the city of Semarang and its surroundings.

Method

The community service method for improving the skills of high school and middle school teachers in using virtual laboratories based on the PhET Simulation application in the city of Semarang and its surroundings uses the community-based Participatory Action research (CBPAR) approach. In general, there are five stages of CBPAR. The first is Project Design and Implementation, which aims to identify research questions, existing problems, and what follow-up is needed.

Stage two is Partner engagement, which aims to identify action research partners and invite them to collaborate. Stage three is data collection, aiming to refine the research questions, select and apply data collection methods, and identify critical participants. The fourth stage is data analysis, which aims to create and implement an analysis plan. The fifth stage is reporting, which analyzes the results, actions, and dissemination (Burns, Cooke, and Schweidler 2011). This CBPAR service method was also used by the service carried out by Aryani et al. (2022) in training on making multimedia-based learning videos. The stages of implementing community service are as follows:

1. Preparation

   In the preparatory phase, a survey was conducted using a questionnaire of 27 teachers in the city of Semarang and its surroundings to find out the conditions and problems faced by prospective participants. The dedicated team for the Physics Department of UIN Walisongo Semarang coordinated with the Physics Teacher Network (Physics MGMP) of Central Java regarding the socialization of training activities.
2. Implementation

   The training activities were conducted online on September 25-27, 2021, with participants being junior-senior high school physics or science teachers in Semarang City and its surroundings. Before delivering the material, participants filled out a pretest questionnaire about using the PhET Simulations application. The material presented in this training is how to use PhET Simulations. The practicum materials presented are string waves using Wave on a String simulation and light reflection practicum using Bending Light simulation. At the time of delivery of the material by the resource person, the participants directly practicum accompanied by discussion and question and answer.
3. Evaluation

   The final stage is evaluation; at the end of the session, participants fill out the post-test questionnaire after attending the training.

Furthermore, an analysis was carried out to find out the increase in the skills of junior high school teachers in using a virtual laboratory based on the PhET Simulations application in the city of Semarang and its surroundings.

Improving the skills of junior high school teachers in the city of Semarang and its surroundings before and after participating in virtual physics practicum training can be identified by completing a self-assessment questionnaire containing four aspects of the ability to carry out virtual physics practicum. Questionnaires distributed to teachers or participants in this activity can be seen in Table 1

Table 1

Self-Assessment Questionnaire

Questions	BM	KM	M	SM
Accessing the Virtual Practicum Application				
Using the PhET application via a browser				
Download one of the simulations on the PhET app				
Using the PhET application as physics practicum media				

Information:
BM : Not Mastering yet
KM: Less Mastering
M : Mastering
SM : Very Mastering

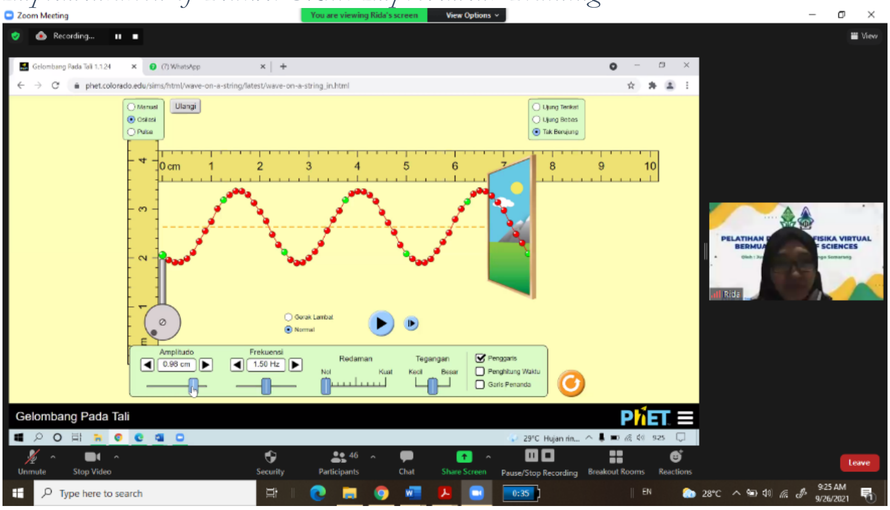
The increase in teacher skills is known based on the average interval scale of the participants' self-assessment converted to an ordinal scale, and then the n-gain test is carried out. If n-gain $\langle g \rangle \geq 0.7$, then it is considered high. It is a medium criterion if n-gain is $0.7 > \langle g \rangle \geq 0.3$. An increase is considered a low criterion if $\langle g \rangle < 0.3$ (Hake 1999).

Discussion

The main target of this training is junior high school teachers in the city of Semarang and its surroundings. In practice, several teachers from various cities in Indonesia, such as Jakarta, Bogor, Batu, Palembang, Sorong, and Bima, took part in this training. In the first session, this training activity was attended by 77 participants; in sessions II and III, it was attended by 62 participants. However, only 37 participants filled out all the questionnaire data completely. Documentation of training implementation is shown in Figure 1.

Figure 1

Implementation of Teacher Skills Improvement Training

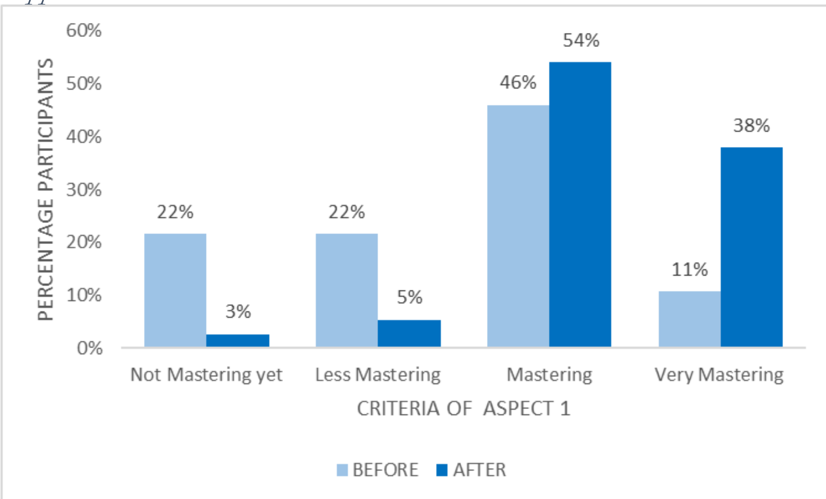


Participants needed to be more consistent in participating in this training due to signal problems. Following are the results of the analysis of the self-assessment questionnaire from 37 training participants.

1. **Ability to access virtual practicum applications.**
   Figure 2 shows the ability of participants to access virtual practicum applications, especially PhET, before and after receiving training.

Figure 2

Percentage of Participants. Ability to Acces the Virtual Practicum Application



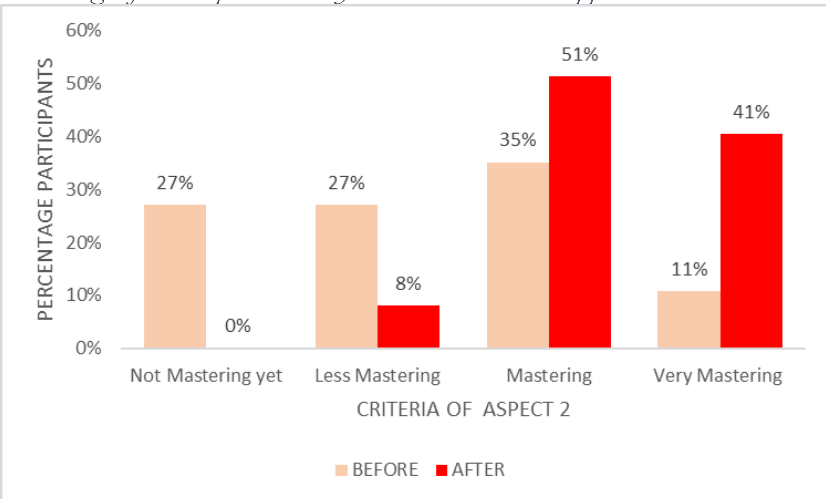
Participants' ability to access the PhET Simulations application in the very mastering category increased by 27%. Likewise, participants' ability in the mastering category increased by 8%. Figure 2 shows differences in participants' ability to access virtual practicum applications using PhET Simulations after receiving training. 3% of participants have not mastered it, and 5% are less mastered participants; this happened due to signal problems at each participant's place.

2. Ability of participants to use the PhET Application

One of the materials presented in this virtual physics practicum training is how to directly access the PhET simulation application and be practised by the participants. After receiving the training, the participants who had not mastered and lacked proficiency in using the PhET simulations application via the browser were reduced to 0% and 8%; this is in line with the increase in the percentage of participants who are proficient in using the PhET Simulations application by 16% and 30% as shown in Figure 3.

Figure 3

Percentage of Participant Ability to Use the PhET Application

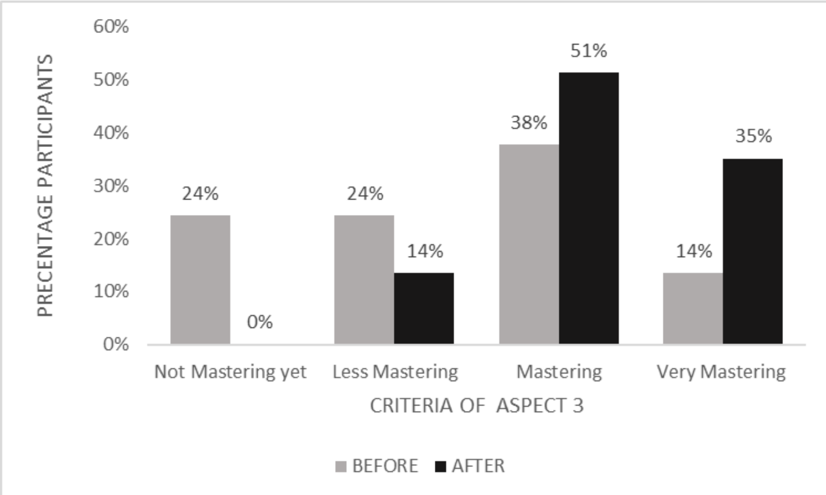


This reduced percentage indicates that this training can help participants improve their Ability to access PhET simulation applications.

3. **Download the PhET Application Simulation**

   The percentage of participants who were mastered and very mastered experienced an increase of 13% and 21% as shown in Figure 4. The increase in the ability of participants to download this application was proven by the participants who successfully downloaded the simulation.

Figure 4
Percentage of Participants' Ability to Download PhET Application Simulation



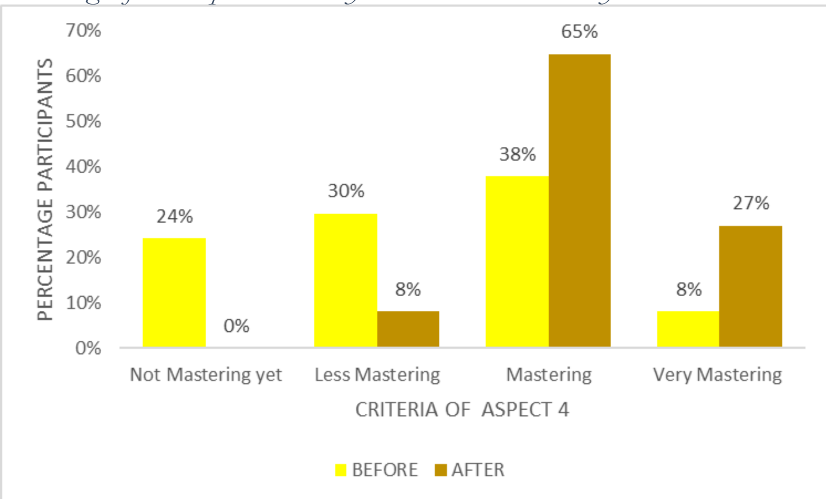
The questionnaire results showed participants who had not yet mastered and less mastered, respectively, by 24%, as shown in Figure 4. The change in the percentage of participants who had not mastered after receiving training became 0%. However, participants who were less master in downloading the PhET application still had 14%. While downloading the simulation in the PhET application, the participants did not download and install supporting applications such as Java; this caused participants to be unable to open the application offline on each participant's laptop or mobile phone.

4. **Using PhET as physics practicum media**

The PhET application can be used as a support for learning media and as a means for virtual practicum. The percentage of participants who can master and very master has increased by 27% and 19% as shown Figure 5.

Figure 5

Percentage of Participant's Ability to Use PhET as a Physics Practicum Tool

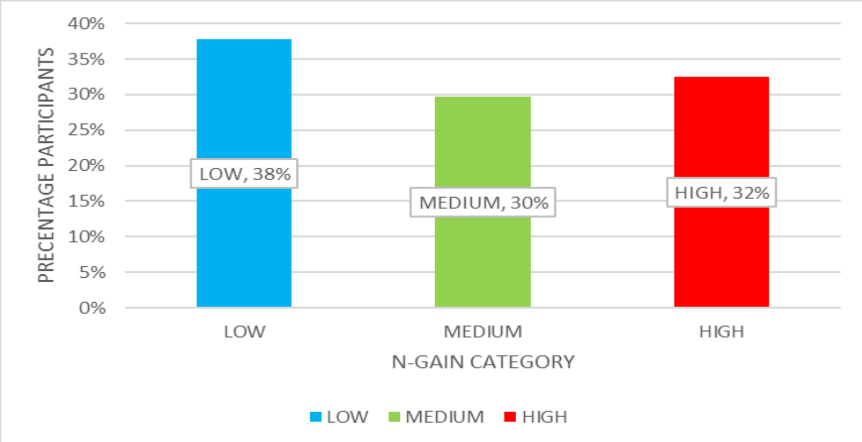


Based on Figure 5, participants who lack mastery in using PhET simulation as a means of carrying out practicums after receiving training are still 8%. Participants who need more mastery to determine the practicum's dependent variable, control variable, and independent variable. In addition, participants also could not run the application because of the many buttons and symbols in the application.

Furthermore, an analysis of teacher skill improvement was carried out for each participant using the n-gain test. The results of the average interval scale for each participant were grouped based on the criteria, as shown in Figure 6.

Figure 6

Percentage of Participant Skill Improvement Based on the N-Gain Test



There were 32% of the 37 participants whose improvement was included in the high category. The participants often use the PhET application as a virtual laboratory. As much as 30% of the participants who experienced an increase in skills in the moderate category were participants who were familiar with the PhET Simulation application as a virtual laboratory but had not implemented it in the learning process. 38% of participants in the low category were participants who were not familiar with the PhET Simulations application.

The results of this service training are measured not only by understanding PhET Simulation but also by Based on this training assistance, the results of the virtual practicum activity sheet for waves on ropes based on PhET simulation were obtained. The simulation used in this virtual practicum is a wave on a string. This activity sheet contains the title, objectives, theoretical basis, tools and materials, how the observation table works, and a list of questions. During the mentoring process, participants are asked to carry out experiments by varying the amplitude variable to obtain data about the number of waves and wavelength. The second variation of the variable is frequency, which is used to obtain the dependent variable in the form of a number of waves, wavelength, and wave propagation speed. The third variation of the variable is the rope tension, so the dependent variable is the number of waves and wavelength. It is hoped that this mentoring process can ensure that participants not only gain understanding but also direct practical experience and can fill out the activity sheet correctly. Teachers can use this activity sheet to support the virtual practical learning process using PhET simulation.

Conclusion

There has been an increase in the skills of junior high school teachers in using virtual laboratories based on the PhET Simulations application in the city of Semarang and its surroundings after the training was carried out. The four aspects measured are accessing the virtual practicum application (PhET), using the PhET application through a browser, downloading a simulation on the PhET Simulations application, and using the PhET Simulation application as a means of physics practicum. As much as 32% of the participants increased their abilities in the high category, 30% included in the medium category, and 38% included in the low category.

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