PILLAR OF PHYSICS EDUCATION
Vol. 16 (3), 2023, page.254-259
DOI : 10.24036/2632171074
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

Improving the Capacity of Physics Teachers in the Development of Laboratory Experiment Kits Based on Video Analysis and Modeling Tool

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ABSTRACT

Science subjects really need a learning model that makes students learn a lot from experience, not from verbal speeches and memorizing concepts given by the teacher. Experience can only be gained through practical activities and experiments which can ultimately improve students' science process skills. The reality in the field shows that physics experimental activities cannot be carried out optimally because a lot of equipment cannot be operated, the number of experimental sets is not enough and the equipment needed is quite expensive. The aim of this research is to increase teachers' skills in developing low-cost laboratory experimental kits by combining technology from video analysis and modeling tools with the research object being the physics MGMP teachers of Agam district. Implementation stages include providing training/workshops, practical implementation and evaluation of results. After carrying out this activity stage, the results obtained are video analysis products from participants and student worksheets. The results of this research can be analyzed and concluded that physics teachers' understanding and skills in carrying out video-based practical activities have increased due to limited practical equipment in the laboratory. The increase in participants' understanding can be seen from the results and their satisfaction with the implementation of laboratory experiment kit development activities based on video analysis and modeling tools. Therefore, improving these skills has a very good impact on teachers to increase learning variations that attract students' interest, and assist students in understanding Physics concepts correctly and being able to find their best potential.

Keywords : Video analysis, Tracker, Physics Experiment

I. INTRODUCTION

Physics is a branch of science that studies the properties, phenomena and phenomena of nature. The Merdeka curriculum is also required to explore learning activities from other learning sources such as nature and the environment to find the best concepts[1][2]. In seeing these symptoms, a physics scientist uses the process of observing, measuring, analyzing and drawing conclusions [3]. The physics learning process in schools must also implement these aspects so that students are expected to be able to understand physics well. Currently, a teacher's duties are increasingly complex and challenging, so teachers must have adequate skills to carry out the learning process in school. To carry out this process, a teacher really needs a learning model that makes students learn a lot from real experiences around them, not from verbal speeches and memorizing concepts given by the teacher. Subjects such as science are one of the subjects that can increase students' understanding of nature and its surroundings. Students' ability to learn science is not just about learning the content, but also knowing how facts are gathered from observations and interpreting relationships. The procedure of collecting facts and interpreting them is called the process of science[4]. Experience can only be gained through practical activities and experiments which are ultimately expected to improve students' science process skills.

Experimental activities are the main activities carried out by scientists or scientists in finding facts. Experimental activities are carried out through stages such as observing, estimating and taking measurements using equipment in the laboratory[5]. Experimental activities at school will train students to increase their knowledge and abilities in experimenting starting from using tools correctly, taking measurements carefully and interpreting

the results of the experiment well[6]. By carrying out practicum activities at school, it is hoped that students can develop a work mindset and scientific attitude[7]. Apart from that, experimental activities are also needed to discover theories, develop illustrations of concepts and support students' understanding of learning material.

Experimentation is a very important activity in the learning process, especially in physics learning. Through practical activities, physics learning will be interesting and students can understand concepts better[8][9]. For this reason, laboratory equipment is a very important means for carrying out practical and experimental activities in the learning process. The availability of quality equipment has an impact on the quality of education provided in schools. To present an experimental set at school is not an easy thing. In almost all state schools, the experimental set for learning is very limited, especially for physics subjects. The reality in the field shows that physics practical activities cannot be carried out optimally because a lot of equipment cannot be operated, the number of experimental sets is not enough and the equipment needed is quite expensive. In addition, designing and conducting experimental sets independently is also hampered by the low level of teacher skills in creating simple experimental tools. This problem is a common problem experienced by physics teachers in schools, including physics teachers who are members of the Physics Subject Teachers' Council (MGMP) throughout Agam district.

Observing the problems experienced by physics teachers, the team felt called to carry out an activity that could help physics teachers overcome these problems. One solution is to provide assistance in developing laboratory experiment kits based on video tool analysis to Physics teachers. In this activity, all teachers who are members of the Physics MGMP throughout Agam district will be given guidance in developing simple experimental kits, which do not require expensive costs and sophisticated electronic equipment and are easy for everyone to operate. Through the development of this kit, physical phenomena are recorded and analyzed using video analysis tools so that various physics concepts can be explained easily.

The Merdeka Curriculum initiated by the government is very supportive of providing opportunities for students to continue to explore themselves outside of school, this aims to find the right concepts, increase learning creativity, and make the learning system more interesting[10]. Apart from that, with the increase in gadget technology which is a necessity for individuals every day, it tends to have an impact that is not good in terms of time management and the influence of games that do not support the learning process, so it is necessary to direct students to use gadgets for learning purposes[11].

The aim of this activity is to improve the skills of physics teachers in developing low-cost laboratory experiment kits using video analysis tool technology. The specific target to be achieved is the creation of several laboratory experiment kits that can be used in physics learning activities for groups of physics teachers in schools. Based on the problems faced, the solution that has been mutually agreed upon is to improve the skills of physics teachers in developing sets of physics experiments based on video analysis using tracker software. This solution is considered important to overcome the limitations of implementing physics laboratory activities in schools and at the same time to improve the quality of physics laboratories in schools. This solution is able to improve the quality of practical activities without using large costs but with a faster process.

The phenomenon of motion or particle mechanics is the most widely seen and accessible physics topic in everyday life. This movement phenomenon will be easier to study through tracker software. This tracker software is open source software which is widely available and easily accessible via electronic devices such as laptops, cellphones and other electronic devices which are included in daily necessities. Tracker is a software system that can analyze videos from modeling tools developed using physics concepts with a Java framework [12].

The working process of the tracker software is capturing data in the form of video from any type of camera device, tracking the object that is the focus of the measurement, carrying out the tracking process on the object and displaying the results of physical quantities in the form of data and graphs [13][14]. This software was developed to assist physics practical activities with limited practical equipment. By using data derived from modeling tools and analyzed using tracker software, students can properly investigate physical phenomena such as changes in position, speed and acceleration over time [15]. Tracker can define particle models in the form of physical analysis and particle dynamics. All models are built using the Tracker Model Builder which provides controls for defining and varying parameters, initial conditions, and position or force expressions [16].

Video analysis developed on tracker software can be used as a new learning resource with creative methods that can open students' horizons to explore and analyze phenomena in everyday life, using accurate data and facts without using a lot of experimental equipment like normal practicums. carried out [16]. Studying the laws of nature using virtual tools based on video analysis will provide an extraordinary experience for students because this software is very illustrative, interactive, inspires students to think creatively, improves their performance and can help in understanding physics [17]. To run this software optimally, it requires assistance from a high-speed camera to compensate for the movement of the object being recorded, so that the physical phenomena of the object can be observed optimally.

II. METHOD

The research method used was quasi-experimental research through pretests and posttests from research samples. This research activity is designed by giving treatment to the sample and seeing the results of the treatment. To see the condition before treatment, a pretest was carried out on the sample. In the next stage, the samples were given treatment for several activities in the form of training in developing a Video Analysis and Modeling Tool-based Laboratory Experiment Kit. Then after training was given to the sample, data was taken again in the form of a post-test. The samples for this activity were physics teachers in the Religious District who were included in the MGMP Physics membership in the Religious District. Samples are included in each step of the activity until completion.

The data collection instrument in this research was created based on three main aspects. First, the knowledge aspect is measured using pretest and posttest instruments. This knowledge aspect aims to measure the knowledge of training participants regarding the development of physics practicum based on video analysis tools. This instrument consists of five questions which aim to measure the extent of participants' knowledge of the use of this tracker software. Pretest and posttest data were taken before the training activity and developments after the training activity was completed.

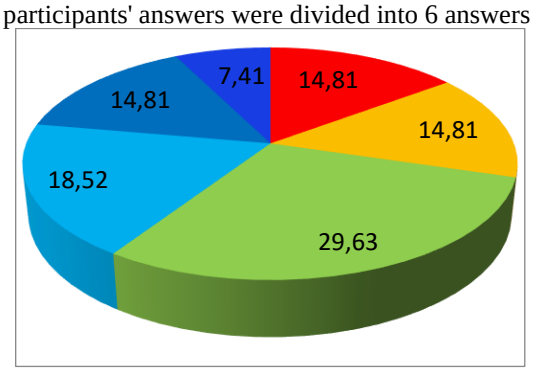
Second, the performance assessment aspect is carried out using performance assessment sheets from participants during the activity with the following assessment categories: whether the resulting video product is in accordance with standard criteria that can be input into the tracker software, video display that can be accessed by physical symptoms, steps - steps in carrying out analysis on the software, and analysis results that suit your needs in the form of graphs and equation formulations.

Third, aspects of training participants' responses are taken from data on participants' responses to activities that have been carried out. This assessment instrument consists of several categories which include: practical activities in the physics laboratory, making modeling tools, video analysis using tracker software, the benefits of training in developing practical activities in the laboratory, and the process of preparing worksheets. Data obtained from the three instruments above are processed using appropriate statistics.

The data analysis technique used is a descriptive analysis technique which includes a description of the data taken from participants in the form of pre-test and post-test as well as the training participants' responses to the activities. Statistical data taken is in the form of maximum value, minimum value, average value and standard deviation. The results of this analysis can describe the level of the data group taken. The normality test was carried out to determine the distribution of participants' improvement in ability from the pre-test and post-test results.

III. RESULTS AND DISCUSSION

Assistance activities for the development of laboratory experiment kits based on video analysis and modeling tools for physics teachers have been carried out at the physics MGMP in Agam district. This activity begins by conducting a pretest to determine the initial condition of the participants before receiving the training material. In the first part, the question was asked, what would the teacher do if there was no practicum KIT available at school? The participants' answers were divided into 6 answers as shown in Figure 1 below.



4.8% ➔ Theory Only
14.8% ➔ Replacement Equipment
29.63 ➔ make simple tools
18.52% ➔ Using nature
14.81% ➔ use software
7.41% ➔ provide data and request students process

Figure 1. Statistics of Participants' Initial Conditions

From the pre-test results, it can be seen that the participants were very enthusiastic about carrying out practicum activities even with the limited tools and practicum KIT available at school. From the picture it is also known that 14.8% of participants were only interested in teaching theory, while 85.2% of participants wanted practical activities to be carried out. It is hoped that this tool analysis video can help in practical activities.

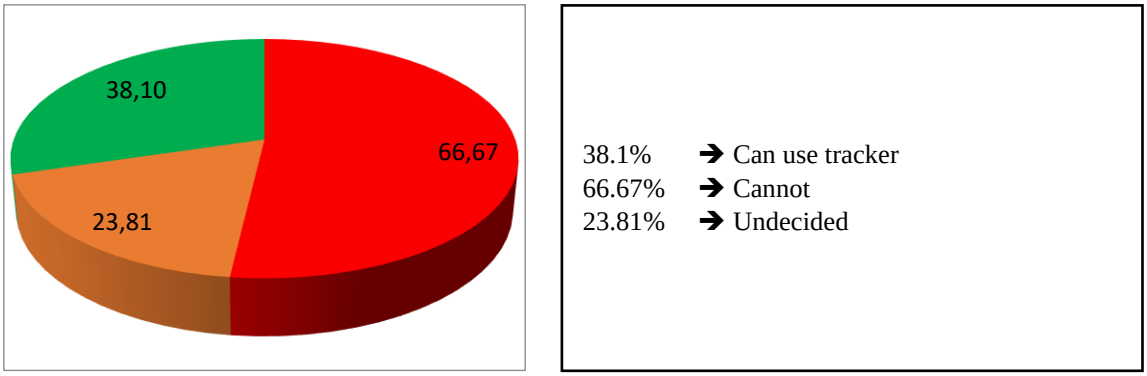


Figure 3. Initial Condition of Participants' Understanding

Based on the results of the analysis of the initial conditions of the training participants before carrying out mentoring activities, it was found that 66.67% did not understand the use of tracker software and only 38.1% were able to use tracker software. Therefore, it is very appropriate to carry out mentoring activities to develop laboratory experiment kits based on video analysis and modeling tools for MGMP Agam physics teachers. Assistance activities for the development of laboratory experiment kits based on video analysis and modeling tools for physics teachers have been carried out at the physics MGMP in Agam district. Mentoring activities were carried out three times. From this mentoring activity, three products were produced, namely in the form of video analysis products from participants, worksheets and training participants' responses to the implementation of training activities.

In the activity of developing a laboratory experimental kit based on video analysis and modeling tools, each participant was asked to make a video of the movement of objects related to motion kinematics. Then, participants were asked to analyze the video using tracker software. The process carried out by participants is to take the recorded video file, save the recorded video in a certain folder, run the tracker software, then analyze the video using several steps in the tracker software. The data produced from using the tracker is data from actual practical activities, so that the results of the analysis can be trusted and are in accordance with theory,

To get better and more controlled results, activity participants were asked to make videos and analyze them at their respective schools and the results were presented at the next training and collected in the form of practical worksheets. In the training activity for developing laboratory experimental kits based on video analysis and modeling tools for Agam district, 8 products were produced which were made by teachers from the Physics MGMP of Agam district. The resulting product is a video of object movement and its analysis. Analysis of videos of object motion made by participants included videos of uniformly changing rectilinear motion, videos of parabolic motion, videos of harmonious oscillations of free fall motion, and videos of circular motion.

At the end of the video analysis and modeling tool-based laboratory experiment kit development activity, participants were asked for their responses to this activity via a questionnaire. The questionnaire instrument consists of five components, namely a description of physics laboratory activities, responses to making modeling tools, responses to video analysis with tracker software, and the benefits of training for laboratory development and knowledge of how to prepare Physics worksheets. Each component consists of five statements. The assessment results from the responses of the physics MGMP participants in Agam district are shown in Figure 3.

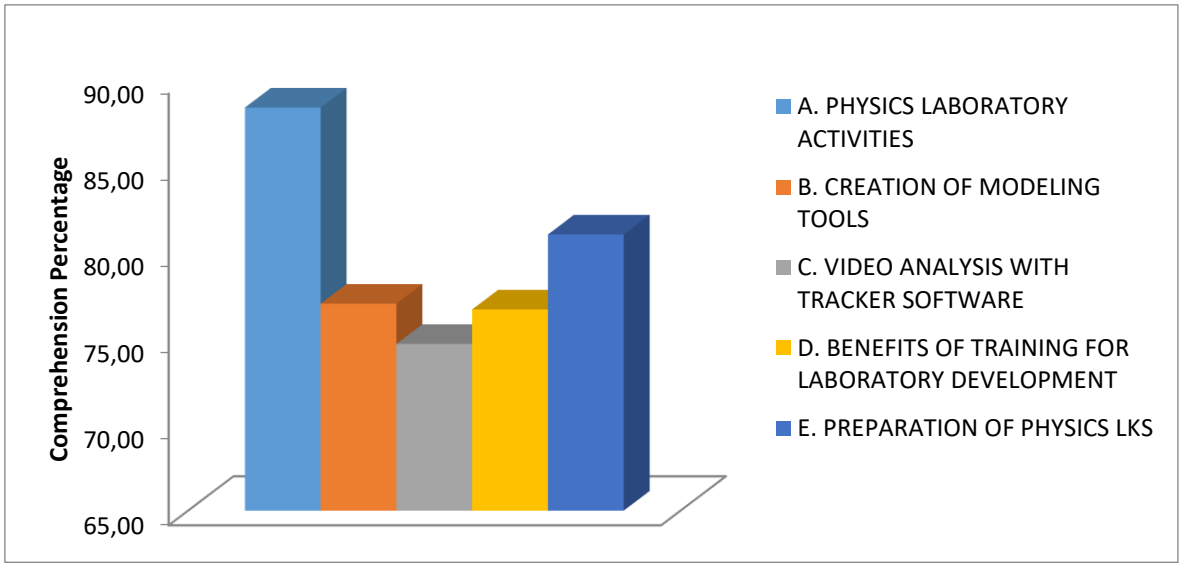


Figure 3. Results of Participant Responses

Based on Figure 3, it can be explained that 88.33% of training participants already have a clear picture of physics laboratory activities that can be carried out at school. This value is included in the very good category. For the knowledge component of how to prepare physics worksheets, it is also in the very good category. Components in the good category are the ability to create modeling tools, the ability to analyze video with tracker software, and the benefits of training for laboratory development. Thus, it can be concluded that participants have been able to carry out and develop physics experiment kits based on video modeling tools to improve the quality of learning outcomes and the physics practice process. The average value for the video modeling tool-based experimental kit development activity component is 79.53% and this average value is in the good category.

These results are in line with what (Pablo 2018) has done by understanding tracker devices and video modeling[13]. This potential can be improved and exploited in fields other than mechanics. Besides that, it is in line with research (trocaru 2020), that this system can emphasize physics concepts, and to motivate students to explore physics concepts in everyday life[18]. The increase in participants' understanding can also be seen from their satisfaction with the implementation of laboratory experiment kit development activities based on video analysis and modeling tools, their confidence in applying training materials to improve science processes in the laboratory and the teacher's ability to prepare physics worksheets well. Then the improvement in participants' skills can also be assessed from the video analysis products that have been produced by participants in this training activity.

IV. CONCLUSION

Based on the results of the data analysis that has been carried out, conclusions from this activity can be put forward, namely: a) Participants are very enthusiastic about carrying out capability development activities in developing practicum KIT, because 85.2% of participants want practicum activities to continue to be implemented. b) Participants have been able to carry out and develop physics experiment kits based on video modeling tools to improve the quality of learning outcomes and the physics practice process. The average value of all components of the video modeling tool-based experimental kit development activity is 79.53 and this average value can be categorized as good. c) The increase in participants' understanding can be seen from the increase in participants' test scores, their satisfaction with the implementation of laboratory experiment kit development activities based on video analysis and modeling tools, namely 88.3% and from the product in the form of worksheets produced by physics teachers.

ACKNOWLEDGMENT

The authors would like to thank PNBP Institute of Research and Community Service (LP2M) Universitas Negeri Padang for community service funding this work at 2018

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