

PRAKTIKUM SAINS DI ERA PANDEMIK COVID-19 MENGGUNAKAN TRACKER VIDEO
SCIENCES PRACTICUM IN THE COVID-19 PANDEMIC ERA BY USING A VIDEO TRACKER

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Abstrak: Kebijakan pencegahan pandemi Covid-19 berdampak pada berkurangnya program praktikum yang harus dibina bagi mahasiswa. Dalam makalah ini, kami menunjukkan bagaimana video tracker telah efektif dalam mencapai praktikum gerakan lurus berubah beraturan dan menentukan gravitasi bulan dengan menggunakan e-learning, diskusi kelompok, analisis video gerakan jatuh bebas pada percepatan gravitasi bulan. Setelah penerapan video tracker, hasil analisis data kuantitatif dan kualitatif menunjukkan bahwa mahasiswa angkatan 2018 pendidikan fisika Universitas Negeri Surabaya memiliki pengalaman yang signifikan dan berkomentar positif terhadap pengalamannya. Siswa menunjukkan bahwa mereka puas dengan lingkungan praktikum dengan menggunakan video tracker, dan penerapan video tracker untuk mengetahui percepatan gravitasi bulan untuk meningkatkan kemampuan keterampilan mereka dalam melakukan percobaan. Praktikum gerak lurus berubah beraturan dan penentuan percepatan gravitasi bulan dengan menggunakan video tracker yang dijelaskan dalam artikel ini dapat dijadikan acuan untuk memastikan kualitas program praktikum sains online selama pandemi Covid-19. Hasil penelitian menunjukkan bahwa lingkungan praktikum berbasis video tracker dapat melatih keterampilan laboratorium IPA berupa memprediksi, mengamati, menjelaskan, dan menganalisis data video pada fenomena ilmiah.

Kata Kunci : pandemi COVID-19, praktikum sains, video tracker, percepatan gravitasi bulan

Abstract: The covid-19 pandemic prevention policy has the impact of reducing practicum programs that should be trained for students. In this paper, we show how a video tracker has been effective in achieving straight motion practicum and determining the moon gravity by using e-learning, group discussion, free fall motion video analysis on the moon's gravity acceleration. After the application of the video tracker, the results of quantitative and qualitative data analysis showed that the 2018 class students from physics science education of the State University of Surabaya had significant experiences and commented positively on their experiences. Students show that they are satisfied with the practicum environment by using a video tracker, and the application of a video tracker to determine the moon's gravitational acceleration to improve their skill proficiency in conducting an experiment. The straight motion practicum and the determination of the moon's gravity acceleration by using the video tracker tool described in this paper can be used as a reference to ensure the quality of the online science practicum program during the Covid-19 pandemic. The investigation results show that a video tracker-based practicum environment can train science laboratory skills in the form of predicting, observing, explaining, and analysing video data on scientific phenomena.

Keywords : *COVID-19 pandemic, sciences practicum, video tracker, the moon's gravitational acceleration*

INTRODUCTION

Since there have been signs of the entry of the Covid-19 virus, teaching and learning processes in primary, secondary and tertiary schools around the world have begun to be considered and prepared to be implemented online. Taking into account the need for learning, various inputs from experts and organizations and taking into account the public safety, governments from various countries have made restrictions related to the implementation of learning, especially in the red zone (prone areas of Covid-19 infection). In the green zone (areas that are considered safe from Covid-19 infection), face-to-face learning can be carried out but are required to implement very strict health protocols. The governments of several countries have granted practicum-learning permits for several schools or

colleges. The implementation of practicum learning for students is allowed in both the red and green zones by obliging the implementation of health protocols strict. However, the reality is both schools and parents of students are still hesitant to give their children's permission to study in school, so that this practicum learning cannot be implemented optimally during the Covid-19 pandemic [1].

This Covid-19 pandemic has dramatically disrupted school activities around the world. Social distancing requirements have resulted in many countries closing physical school buildings or remaining open but providing a hybrid model of outside classroom teaching and learning. This condition raises various challenges for the Initial Teacher Education (ITE) program, which is located in the context of Higher Education (HE), especially

in fulfilling practicum requirements [1]. Because the new pathogenic characteristic of Covid-19 is highly contagious, implementing health protocols and large-scale social restrictions (PSBB) is inevitable to prevent its rapid spread at the community level [2]. As a result, like most professional activities, the daily activities of schools / colleges and laboratories are suspended in schools, colleges and universities around the world for an indefinite period. However, radical advances in information technology and modern tools allow us to stay connected and do well to learn science from home while living at a safe distance [3].

As educators, we must strive to continue presenting a quality-learning atmosphere in the classroom and online learning. In an effort to improve the quality of learning, suggests that science teachers try to expose their students to the real process of science as explicitly as possible. Goh, J et al. (2011) also paid attention to the importance of original data obtained from nature (real data), "... perhaps one of the most significant things you can do in your classroom is to give students the opportunity to work with real data'.

Science learning is ideally delivered by presenting facts, objects and or scientific phenomena to students directly. The problem is that, sometimes there are phenomena that can be observed directly, but cannot be easily analyzed by students. For example, the phenomena of two-dimensional motion, such as regular straight motion, accelerated straight motion, motion of balls, free fall motion, motion on inclined planes etc. These phenomena can be easily observed in the real world. However, when students observe this phenomena, not much information can be obtained. In this event, it is difficult for students to know how much the initial velocity is (v_0), how much the acceleration is (a), how much the final velocity is (v_f), how much the velocity at a certain time is (v_t). This data is very difficult to be obtained from observation if learning is carried out only with the help of commonly used tools such as ticker timers, stopwatches and so on.

One of the impacts of the difficulty in obtaining meaningful information from a real-world phenomena is the tendency for teachers to present the concept directly in front of the class without going through investigative activities. Lack of investigative activity will cause students to be less trained in carrying out scientific investigation processes and ultimately not accustomed in interpreting real-world phenomena. Therefore, we need a breakthrough in how to develop a learning model that can facilitate students to investigate real phenomena from the real world by utilizing information technology to overcome the constraints of limited human observation abilities. Teachers need to consider utilizing information technology that can help students in retrieving data, presenting data and more accurately interpreting the results of an investigation of scientific phenomena from the real

world in science learning, especially in the era of the Covid-19 pandemic.

Tracker is a relatively new pedagogical approach called 'video modelling' [6]. The recent version Video Tracker analysis is 5.15. The free software of Tracker tool used in this 'video modelling' can be downloaded from the Open Source at <https://www.compadre.org/osp/items/detail.cfm?ID=7365>.

Ordinary e-learning courses are not enough to practice skills about laboratory experiments or scientific data analysis [1]. In this regard, video trackers add a new dimension to web-based digital learning [8]. Video trackers are round-the clock available and the replicas are easily accessible. Video modelling pedagogy is suitable for active and deep learning because the students can be said to be predicting by keying certain values, observing by comparing the real data with the current proposed model, and explaining [9,10] their choice of values and making sense of the video analysis data. Even with incorrect models proposed, the results from the world view and associated multiple representational views [11] in various scientific plots can allow the facilitation of data driven social discussions among students and teachers. This article provides insight into studies that test student laboratory skills based on a video tracker to support students' science practicum experiences in online science learning.

Tracker Video Analysis & Modelling Tools

One application that can be used to help students learn various phenomena of two-dimensional motion is Tracker Video Analysis. This application was developed by Java Open Source Physics (OSP) and has the ability to track the motion of an object, so that various needed information in two-dimensional motion analysis can be obtained. Through the activity of recording a real motion phenomena by using a video recorder (handy came), then the results of the recording are processed in the Tracker Video Analysis application, so students can get a variety of information such as the position of objects (x , y) at each time (t), so that it will provide easiness in the motion analysis process.

Tracker is a software that is capable in analyzing and modelling motion and optical phenomena, free of charge, and developed by Open Source Physics (OSP) by using the Java framework [12]. Through the tracker, educators and or students can easily analyze real-world problems, especially on the topic of motion and optics which are sometimes impossible to do without the help of technology. As mentioned by Bryan [13] "inexpensive video analysis technology makes possible the investigation of numerous types of motion with detail and precision that would be incredibly difficult, if not impossible, without the use of this technology".

In simple terms, Tracker has the ability to track the motion of an object so that various needed information in the analysis of a motion event can be

obtained. Through the activity of recording a real motion phenomena by using a video recorder (handy came), the recording results can be processed in the Tracker application. In this way, we can interpret the various displayed data on the device, making it easy for us to carry out an analysis of the motion phenomena. Trip [14] in a study found that the use of video analysis in learning would change the learning practices of teachers in teaching their students. These changes occur due to several things, they are: (a) *focus their analysis*, (b) *see their teaching from a new perspective*, (c) *feel accountable to change their practice*, (d) *remember to implement changes*, and (e) *see their progress*.

Steps of Tracker Usage

How do I use the tracker? To answer this question, the following is the standard steps that must be taken in using a tracker to analyze a motion. **First**, Install the Tracker Video Analysis & Modeling Tools program, which is an application that can be accessed freely. This master program can be downloaded through the address <https://www.compadre.org/osp/items/detail.cfm?ID=7365>. After successful downloading, do the program installation process on the computer. This program can run on Windows, Mac OS, and Linux operating systems. To run this application, the computer must be supported by Java 1.6 program or a higher version.

Second, Recording Motion Phenomena, the working principle of the tracker is to analyze motion phenomena that have been recorded in the form of video files. Therefore, the first step that we must take is to prepare a motion video to be analyzed. For example, if we want to analyze a parabolic motion, then throw the ball at a certain elevation angle to form a parabolic motion. While the ball is moving, record it by using a handy came or smartphone. However, to get a video that can be analyzed, there are a few things to note: Choose an object with a bright colour. In this example, we can use a tennis ball that is bright green; select a background that has a dark colour.

In principle, the colour of the moving object (ball) should be sufficiently contrast to the background colour, place a one-meter ruler on the background, and make sure that this line will appear during video shooting. This ruler will eventually be used as a tool to calibrate the length during the "track" process, and then take multiple shots for the best results. If recording by using a smartphone, it is recommended that you shoot in landscape or portrait position. This is done in anticipating so that we get the right video orientation for analysis. After the recording process, transfer the recorded file to a computer that has the tracker installed. **Third**, open the program.

Open the Tracker program by double clicking the Tracker shortcut on the computer desktop. **Fourth**, inserting a video, choose the File> Open

File menu in the left corner. After that, look for the video file about the motion that we saved on the previous computer. **Fifth**, Selecting a Video Frame. If the video has been successfully inserted into the tracker workspace, the next step is to select the part of the video to be analyzed. Usually, not all parts of the video are important to be analyzed. Therefore, we have to cut the unnecessary parts. The trick is to play the video first so that we can find out which part of the video is needed to be analyzed. In the lower left corner, there is a red number to show the frame number. As long as the video is playing, pay attention to the numbers in that section, then decide on which frame the video will start and at what frame the video will end (finish) for analysis purposes. After that, click the "Clip Setting" icon (Negative Film Image), then write down the numbers on the Start Frame and End Frame. **Sixth**, Long Calibration. The next step is to give a long definition (Calibration). As mentioned earlier, when doing the recording process it is necessary to place a one-meter long ruler. The ruler length will now be used to define the length for this analysis.

The trick is, click Calibration Tools> New> Calibration stick so that a blue line appears on the Tracker workspace. Change the number 100.0 to 1,000, and then move the ends of the blue line to the ends of the one-meter ruler on the video display. In this way, we have calibrated the length of the ruler to one meter. **Seventh**, Enter the Coordinate Axes. Make a Cartesian coordinates (X, Y axes) in the workspace. Click the Coordinate axes icon, then in the workspace two purple lines will appear intersecting perpendicularly as the coordinates of the object's position. Then shift these coordinates by placing the origin (0,0) on the object (ball) at the Start frame. Once successful, hide the coordinates by clicking once again on the Coordinate axes icon. **Eighth**, Creating "Point Mass". Define the mass of the object by clicking Create> Point Mass icon so that a box that says Point Mass A will appear. In an experiment that considers the mass of the object, enter the mass value of the object in the box. However, in the case of the parabolic motion, the mass of the object has no effect at the time of analysis, so we can leave the number in the box as 1. **Ninth**, Making the Path of the Object's Movement. This step is the culmination of the activity "track" moving objects. We can choose two techniques, namely manual techniques and automatic techniques.

The following describes each technique: a) Manual technique. Press the "Shift" key on the keyboard, then at the same time hover the cursor over the surface of the object (ball), then do the left click. A moment later the object (ball) will move to the next frame, and then do the same thing by pressing the "Shift" key and clicking on the object's surface (ball). Do this step continuously until you reach the last frame. If this step has been carried out, the graph and table of time (t) and position (x & y) will automatically appear on the right side of the

screen. b) Automatic Technique. Click the Point Mass A> Auto tracker box, so that the Auto tracker box will appear. Press Shift + Ctrl on the keyboard then put the cursor on the surface of the object (ball), then do the left click so that it will activate the "search" button on the auto tracker box. Then click the "Search" button so that the object (ball) will move automatically. If the ball stops (even though it has not arrived at the last frame), then click the "accept" button at the bottom of the box until the object (ball) moves again. If this step has been carried out, the graph and table of time (t) and position (x & y) will automatically appear on the right side of the screen.

Tenth, Analyzing Tables / Graphs. If the process of creating the path has been successful, then on the right side of the Tracker workspace two important sections will appear, namely the Position and Time Graph, and the Position and Time Table. We can change what variable / quantity we want to display by clicking on the axis title, then changing it with the desired variable. For example, on the letter "x" we click, it will display a selection of symbols for other variables, such as "y", "vx", "vy", etc. To perform further analysis, double click the graphic area, it will display the "Data Tool Box". Through this box, we can do a lot of graphic analysis for the motion that we have recorded. Click the "Measure" menu then select "coordinate", "slope" and "area". After that, click the "Analyze" menu and select "Statistics" and "Curve Fit".

Based on the various information contained in the Data Tool Box, there will be a lot of data and graphs that we can analyze. As an example in the image above, we have just analyzed the graph of position (y) and time (t). On the upper right side, there are several statistical data such as maximum, minimum, average, and standard deviation values. While below it, we can see the position value (y) which continues to change according to changes in time (t). At the bottom of the graph we are shown the equation $y = A * t + B$ with the value $A = 2.315E0$ and $B = 1.359E-2$. What do the numbers mean? If you pay attention, it is a linear line equation where y refers to the position in the vertical direction (y), A is the slope (*gradient*) of the formed linear line, and B shows the initial value of the object's position. The slope (*gradient*) value on the graph refers to the change in the position value (y) per time unit (t) or y / t . We know that the position of each unit of time is the velocity. Therefore, the value of A in the equation provides information on the average velocity of objects on the y-axis (Sabar Nurohman, 2012).

METHOD

Before students conduct a practicum on determining the moon's gravitational acceleration, students had been trained online in the Covid-19 era to download and install a video tracker tool, and use it to analyse free fall motion videos. They have also

passed the skill test to analyze free fall motion videos. Students who do not pass the exam are not included in practicum activities to determine the moon's gravitational acceleration. There are 75% (30 people) of students who are eligible to participate in this advanced practicum activity. Next, they were asked to download the experimental video of a hammer and a feather dropped on the moon surface at the same height and time by an Apollo 15 astronaut in 1971 named David Scott at the following link

<https://www.youtube.com/watch?v=Oo8TaPVsn9Y&feature=youtu.be>.

After that, the students were asked to analyse the video to determine the moon's gravitational acceleration in 90 minutes. The video analysis result files of the students in the trk format and the fitting data files were collected via email for both quantitative and qualitative assessments. Researchers also conducted qualitative surveys and informal interviews with students to obtain qualitative data about learning by using a video tracker tool, a tracker tool in practicing inquiry and thinking like a scientist, and the faced obstacles in using the video tracker tool

RESULTS AND DISCUSSION

Video analysis of the moon's gravitational acceleration determination

The mathematical equation that represents the free fall motion is

$$y = y_0 - \frac{1}{2}gt^2 + v_0t \quad (1)$$

Where y is the object's height (hammer or feather) at time t , y_0 is the object's initial height at $t=0$ seconds. g is the determined gravitational acceleration (moon) in this experiment, and t is the time it takes for the object to travel the height of y . After using the video Tracker to track the projectile trajectory manually or automatically, the data tools can be used to analyse the motion and allow the determination of numerical values of quantities such as the gravitational acceleration of the moon, g of the moon. This can be done by comparing the fitting coefficient of the parabolic curve as in equation (2) with equation (1).

$$y = At^2 + Bt + C \quad (2)$$

Where A, B, and C are the coefficients of the parabolic fitting curve. The values of A, B, and C can be seen in Figure 3, where $A = -0.8421$, $B = -0.1074$, and $C = -0.07193$. To determine the gravitational acceleration value of the moon, g , then the coefficient of t^2 in equations (1) and (2), so that $-\frac{1}{2}gt^2 = -0.8421t^2$ or $g = 2(0.8421) = 1.68 \text{ ms}^{-2}$. Figures 1, 2, and 3 below are one of the results

presentations of video analysis by students to determine the moon's gravitational acceleration.

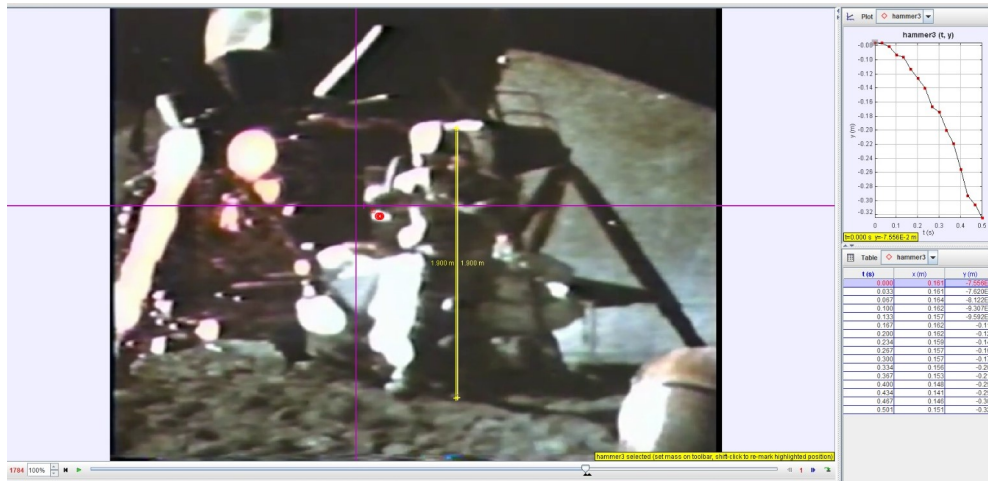


Figure 1. Video of David Scott's early hammer dropping on the initial 1784 frame and for the purposes of the astronaut's 1.9 meters high calibration

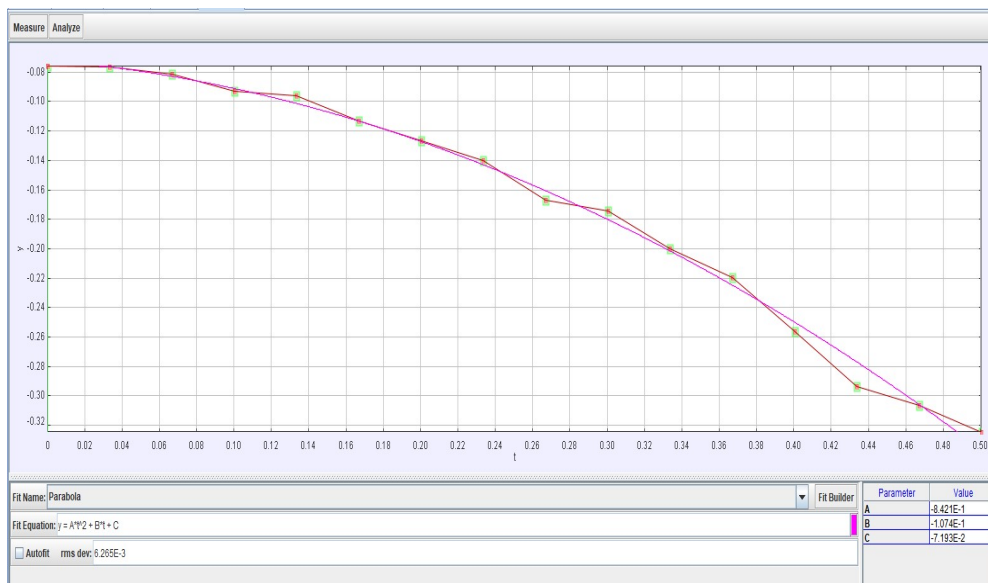


Figure 2. The parabolic fitting curve of the fall hammer and in this case the obtained coefficient value of A = -0.8421, B = -0.1074, and C = -0.07193

Most of the students have good video analysis skills. This can be seen from the quantitative and qualitative data from the results of laboratory activities to analyse the video to determine the moon's gravitational acceleration as shown by Fig. 1 and Fig. 2. In Fig. 1, most students can already predict whether hammer or feather is used for free fall objects. Because the hammer object in the video is relatively clearer than the feather object, almost all students chose hammer as the free fall object on the moon. Most of the students have the ability to observe the phenomena of free fall objects on the moon as shown in the video correctly. The quality of

the video is not good because the hammer's colour and the background are almost the same, so students need carefulness to ascertain which parts of the video can be analysed to determine the acceleration of the moon. So that Fig. 1 can specify the exact starting frame [6], for example 1784 (red colour to the left of "Play"). Likewise, on Fig. 2, the final frame can be determined, for example 1799. Students also have the skills to calibrate the hammer height at any time against the moon surface, whether in meters or centimetres [6]. The student's calibration ability can be assessed from the accuracy of how many meters of objects on the moon's surface are relatively valid

for calibration. In the video, there are several objects that can be used for calibration purposes, the height of the American flag, the height of the human being, the height of other used objects by astronauts whose images are recorded in the video. Almost all students use astronaut height (David Scott) as a calibration. They assumed David Scott's height was 1.9 m to 2.0 m. The ability to determine which hammer parts in the video can be traced let the students get a representative graphic for the free fall hammer. In this case, most of the students chose a part of the hammer that contrasts with the background. In analysing the derived data from the free fall hammer on the moon video (Fig. 3), almost all students can make and analyse a graph of hammer height, Y vs t (time) and then compare the coefficient of the t^2 parabolic fit curve in equation (2) with equation (1). It is from this comparison that the moon's gravitational acceleration can be found.

To provide information about conditions and processes during learning in the laboratory by using a video tracker tool, the following is a summary of the qualitative survey results and informal interviews with students. In general, students commented positively about fun active learning in online practicum activities by using video tracker tools. The following is a summary of the comments from most students: "The level of my science understanding improves, especially free-fall objects, because I can observe real-life examples of free fall objects on the moon in a fun and interesting way". "I like to conduct experiment with this interesting video tracker tool. Learned a lot in a fun way". "I thought it was amazing how I could determine the moon's gravitational acceleration only by using a video tracker tool just as scientists find the moon's gravitational acceleration, I also understand better how to do so many fun stuffs while doing online lab work by using that tool". "I also quickly adapt in using the video tracker tool and easily overcome when there are initial difficulties in doing practicum". Video tracker tools like virtual laboratories are round-the clock available and an easily accessible figured replica of the real-life laboratories that can provide practical skills of science to the learners [15, 16]. Such track video allows the learners to obtain knowledge and laboratory skills regarding real life experiments [17, 18].

More importantly, a video modelling that is especially driven by data from video analysis, enables students to discover by using evidence and incomplete models proposed by themselves, to gradually and iteratively improve and find themselves a better model for predicting and explaining projectile motion. This has resulted in a very enjoyable "Eureka" experience for our students as they connect abstract concepts and formulas with real-world examples thereby deepening learning.

CONCLUSION

The investigation results show that the straight motion practicum and the determination of the moons' gravitational acceleration by using the video tracker described in this paper can be used as a reference to ensure the quality of the online science practicum (physics) program during the Covid-19 pandemic. The results of the investigation also show that a video tracker-based practicum environment can practice science laboratory skills in the form of predicting, observing, explaining, analysing video data on scientific phenomena. The relative ease of installing and using the Video Tracker to perform in-depth learner-centered video analysis with reference to the theoretical physics model of the ideal free fall motion is discussed in this article. The inferred values from the video analysis are consistent with real data for the acceleration of gravity on the moon surface.

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