Practicum implementation for kinematics using tracker: solutions for practicum implementation during the COVID-19 pandemic

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Abstract. The COVID-19 pandemic has changed various activities, including the learning process. The health protocol requires physical distancing, and learning activities in a “real” class are not allowed. Therefore, practicum has severe problems because students cannot carry it out in the laboratory. On the other hand, practicum has an essential role in learning physics. This paper aims to describe implementing kinematics practicum from home using the Tracker - video analysis software. The use of the Tracker software can help students carry out practicum independently quite accurately. The sample of this research is first-year students at the Faculty of Engineering, Universitas Bangka Belitung. The student was given several tutorials using Tracker via a video uploaded on Youtube. Furthermore, the student is given questions related to increasing understanding of kinematics, the accuracy of the practicum, and responses to the tutorials given. The majority of students welcomed this practicum and felt that they could improve their understanding of kinematics topics. Also, the practicum carried out has good accuracy. The use of Tracker can increase the frequency of use of digital devices and computers. Thus, we hope that it can improve the students’ skills related to Industrial Revolution 4.0 issues.

1. Introduction
COVID-19 is a disease caused by infection with a new type of coronavirus known as the 2019 Novel Coronavirus (2019-nCoV). COVID-19 can cause respiratory problems such as severe pneumonia, which can lead to death. Initially, this virus was spread in Wuhan, China [1, 2, 3]. However, along with the very rapid spread, in March 2020, the World Health Organization (WHO) has declared COVID-19 as a global pandemic. More than 200 countries around the world have been affected by the spread of this virus. In addition to posing a threat to world public health, the COVID-19 pandemic has rapidly transformed various kinds of activities. The absence of a clinically tested vaccine requires multiple life sectors to adapt to current conditions [4].

In responding to the COVID-19 pandemic condition in Indonesia, the Republic of Indonesia's Government has launched various policies to control the spread of COVID-19. One approach that has had a significant impact on education is learning from home policy [5, 6]. To prevent the formation of clusters for the spread of COVID-19 in schools, the Ministry of Education and Culture of the Republic of Indonesia has issued a policy related to teaching and learning activities conducted using distance learning methods [7]. However, due to the pandemic condition, which demands rapid change, the government's distance learning policy still has various problems. Over time, educators must continue
to innovate so that the learning method chosen is following the student's condition. Regarding theoretical learning, the learning process can be carried out through various platforms, either through learning videos or in virtual classes using applications such as Zoom Meeting and Google Meet.

Practicum is one of the learning activities that have problems when the learning process is carried out online. Conventionally, a practicum is carried out in laboratories with various equipment and materials that support the running of experiments. However, when lectures are conducted online, practicum activities become difficult to carry out. Whereas on the other hand, practicum in the field of science and engineering occupies an important position. Practicum can effectively reduce misconceptions and can accelerate student understanding [8, 9, 10]. Also, practicum supports students' motoric development. The solutions that have been offered related to the implementation of the practicum from home are practicum using a virtual laboratory or using simulator software [11]. Maybe, this can support the practicality of practicum, but on the other hand, practicum using simulators have limitations to support students' motoric development.

Therefore, this article proposes a solution for implementing practicum using simple equipment at home. To facilitate data collection and data analysis, we use Tracker software. The use of software assistance for these activities is because the practicum will be carried out independently [12]. Tracker software is a video analysis software often used in physics experiments and is open-source [13]. Thus, using the Tracker does not require additional costs. The focus of practicum activities discussed in this study is related to kinematics, especially free-fall motion and projectile motion. However, using Tracker to help carry out practicum during the COVID-19 pandemic can be expanded to various other topics.

2. Method
This study involved 15 students at the Faculty of Engineering, Universitas Bangka Belitung. These students come from various Sumatra Island regions to ensure the students' economic and social conditions' heterogeneity. To facilitate the provision of material, providing a place for uploading practicum activity reports, and evaluating, the learning process is carried out using the Google Classroom platform. Before being given the practicum implementation material, a survey was carried out related to the initial conditions of students, such as (i) computer ownership and possible solutions if they do not have a computer, (ii) computer usage frequency, and (iii) experience using Tracker. For the practicum to run well, learning materials are compiled consisting of modules in pdf format and video tutorials, which are uploaded on the social media Youtube. In the tutorial, the practicum is done using easy-to-find equipment such as toys (objects to be analyzed), rulers or A4 paper (objects for scale calibration), and smartphones to record video. Students are asked to do a practicum and compile reports according to the modules that have been given. After students are asked to fill out evaluations related to the practicum implementation that has been done. The student is given questions related to increasing understanding of kinematics, the accuracy of the practicum, and responses to the tutorials given. The evaluation results are then used as the basis for declaring the success of the practicum implementation method.

3. Results and Discussions
The survey results related to the students' initial conditions are shown in Figure 1. Based on the survey, it is known that all students involved in this study have computers. Thus, practicum allows it to be held because students can install the Tracker software on their respective computers. However, if it turns out that there are students who do not have computers in the application process, these students already have a solution, including borrowing a friend's computer, joining a small group, or making a lease. This is because, currently, computers have been considered primary devices for students. Approximately 61% of students involved in this study have frequently used computers, but all students have never used the Tracker software. Therefore, it is essential to compile practicum tutorial videos because the Tracker software is still unfamiliar among students.
Figure 1. Survey of students' initial conditions: (a) computer ownership; (b) frequency of computer use; (c) Familiarity using Tracker.

In Figure 2, the students' experiences related to the free-fall motion and projectile motion are presented in Figure 2. It appears that 72.2% of students have never done a free-fall motion practicum, and there are still 16.7% of students who do not know the value of gravitational acceleration. In the projectile motion practicum, it appears that 73.3% of respondents have never done the practicum.

Figure 2. Survey of student experiences in practicum: (a) free-fall motion; (b) projectile motion; and (c) knowledge regarding the gravitational acceleration.

Figure 3 shows the tutorial's video footage for free fall, and projectile motion has been uploaded to Youtube, each with a URL link: https://youtu.be/k1BqJd8CkSQ and https://youtu.be/sCL85PkJa1Q along with responses from the respondents. As many as 66.7% of respondents stated that video tutorials related to free fall practicum were easy to understand, 27.8% stated that they were
straightforward to understand, but 5.6% of respondents stated that videos were difficult to understand. As for the video tutorial for the projectile motion practicum, it was stated that 40% of students stated that the video tutorial was straightforward to understand, and the rest stated that it was easy to understand, and there were no respondents who stated that it was difficult to understand. The increased ability to understand students is due to the increasingly familiar students with the Tracker software. The argument was conveyed because the parabolic motion practicum was carried out after the free-fall motion practicum (with a one-week interval of practicum).

Figure 3. Video footage for practicum: (a) free-fall motion; (b) projectile motion, and the level of video ease of understanding in the practicum: (c) free-fall motion; (d) projectile motion.

Figure 4 presents a histogram of the value of gravitational acceleration obtained by students in both practicums. It appears that in the free-fall motion practicum, the number of respondents who can obtain the value of gravitational acceleration in the range 9.5 - 10.5 m/s² reaches 71.4%. As for the projectile motion practicum, respondents who obtained the value of gravitational acceleration in the range 9.5 - 10.5 m/s² reaches 60%. It is because the projectile motion is relatively more complex than the free-fall motion. However, it appears that the use of Tracker to help implement the practicum independently has a reasonably good accuracy because the overall value obtained is in the range 9 - 11 m/s².
Figure 4. The measured gravitational acceleration values in the practicum: (a) free fall; (b) projectile motion.

In Figure 5, data illustrates the increase in student understanding of the topic of kinematics. It appears that after doing practicum, the majority of students feel an increase in understanding. In the free-fall practicum, as many as 86.7% of students felt an increase in understanding, and 13.3% felt a very significant increase in understanding. In the parabolic motion practicum, as many as 86.7% of students stated that they experienced an increase in understanding after doing the practicum, and 1.67% of students stated that there was a very significant increase in understanding. In comparison, the rest (1.67%) did not experience an increase in understanding. Through these results, it appears that practicum activities from home using Tracker software can help students improve their understanding of kinematics material.

Figure 5. The results of increasing student understanding

Based on the explanation that has been done, it can be stated that Tracker's use for independent practicum activities is excellent to do. The interaction between practicum activities carried out using simple equipment and Tracker will help students get used to using devices to benefit from learning or doing analysis. This capability is an ability needed in the era of the Industrial Revolution 4.0.

4. Conclusion
During the COVID-19 pandemic, the Ministry of Education and Culture of the Republic of Indonesia has determined that the learning process is carried out online. Therefore, practicum activities must receive strict attention, and innovation is needed to be carried out optimally. The integration of practicum activities with Tracker allows students to do practicum independently using simple equipment. Through practicum video tutorials shared through the Youtube channel, students feel that the video can be understood well. Also, practicum activities which are carried out independently can improve students' understanding of kinematics material. Through the two practicums, most students can get the value of gravitational acceleration in the range of 9.5 - 10.5 m/s². It proves that, although
practicum is carried out independently, the use of Tracker can help students to take measurements accurately. Thus, the use of Tracker in physics practicum learning is interesting to be developed further. It is mainly to improve self-study skills and be applied to the distance learning process even after the COVID-19 pandemic.

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