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Improving motivation and science process skills through a mobile laboratory-based learning model

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Abstract

The COVID-19 pandemic has affected all sectors of life, including the education sector. Physics learning activities, especially practicum activities, which so far have been very dependent on laboratory space-based activities, are very disturbed. This study aims to develop students' motivation and science process skills (SPS) during the pandemic. The sample of this study was 3 groups consisting of 90 students from 2 universities in the province of Lampung, Indonesia. The data obtained were analysed using the multivariate analysis of variance technique. The results showed that mobile laboratory-based learning proved effective in developing students' motivation and SPS. Therefore, experimental/mobile laboratory activities based on analytical videos obtained from surrounding physical phenomena can be an alternative for physics learning activities, especially in the current era of distance learning.

Keywords: Mobile laboratory, motivation, science process skills.

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1. Introduction

The COVID-19 pandemic has affected all sectors of life, including the education sector with all areas of study in it. The effects of a prolonged pandemic, quarantine programmes and restrictions on social activities for all aspects of activities, including education, have forced universities and schools to change the education system from campus to home (Tawafak et al., 2021). During the COVID-19 pandemic, lecturers and students were unable to carry out asynchronous learning for an indefinite period of time, but the implementation of learning still had to be carried out by adopting mobile learning (Pebriantika et al., 2021). Although mobile learning has weaknesses, it still provides many benefits in the learning process during the COVID-19 pandemic (Pebriantika et al., 2021; Tawafak et al., 2021).

One of the important skills that science students should have is the science process skills (SPS). SPS involves skills that require more complex experiences such as the ability to observe, develop and utilise objects naturally even at a very young age, in addition to benchmarking skills, collecting data, interpreting data and the ability to hypothesise (Yumusak, 2016). SPS can be developed through experimental activities and practicums are required with the concept of thinking skills that can improve the skills of the science process (Darmaji et al., 2019). SPS are also skills that give students the opportunity to explore through the physics instructional (Karadan & Hameed, 2016).

Another problem in the physics instructional in Indonesia is students' creativity. Factors that are thought to influence their low scientific creativity is the process of learning physics in Indonesia which is generally separated from practical subjects, including physics instructional, that tends to emphasise on the mathematical concepts (Suyidno et al., 2018). Creativity is also one of the skills that is expected to be possessed in the era of globalisation (Hasyim et al., 2020).

Science laboratories are expected to produce activities that are able to develop the skills of the students (Liu et al., 2017). However, practical activities or experiments that are important characteristics of the physics instructional have become very limited during the pandemic era of COVID-19. This is due to the condition of social restrictions in the learning process. An effort to overcome this is to integrate practicum activities with mobile learning activities. With the advancement of communication technology, students can use mobile technology anywhere and anytime to access unlimited educational resources (Ally & Prieto-Blázquez, 2014; Kurniawan & Kuswanto, 2021). In relation to the physics instructional, today mobile learning and asynchronous learning are collaborated, although related laboratory activities are still lagging in their use in physics learning activities (Reagan, 2012). Through practical activities integrated with mobile learning, students can carry out this learning activity anytime and anywhere.

Another problem that must be faced with the policy of distance learning and the utilisation of mobile learning systems is the unstable Internet connection (Reagan, 2012). This connection problem is faced by students in Lampung province where not all regions have a good Internet network.

Based on the problems that have been outlined above, a model is needed to facilitate practical activities during the COVID-19 pandemic. In addition to facilitating experimental activities during the COVID-19 pandemic, it is also expected to improve the ability of the SPS and students' creativity. Henceforth, this article will present the results of the implementation of mobile laboratory-based learning (MLBL). The results of the existing research are believed to be important in providing opportunities for experimental activities in areas where Internet access is poor.

2. Methods

2.1. Research Design

The MLBL stages, activities and supporting elements are shown in Figure 1. The implementation differences between MLBL, Sim-Lab and Cookbook Lab are shown in Table 1.

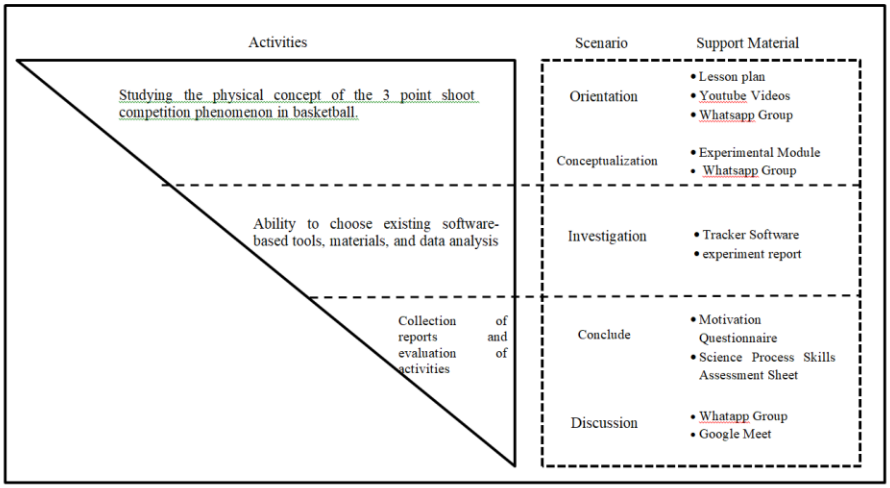


Figure 1. MLBL and an overview of the supporting materials

2.2. Participants

This research was conducted in two universities in Lampung province. The research sample comprised 90 students who received basic physics courses. Students were divided into three groups. The first group of 30 students conducted mobile laboratory-based learning. The second group of 30 students conducted experimental simulation-based activities. The third group of 30 students conducted experiments based on lab cookbooks with attention to healthcare protocols.

Table 1. The Differences of Model MLBL, Simulation Lab, and Cook Book Laboratory

MLBL Models	**Simulation Lab**	**Cook-Book Lab**
No Default Stage	Non-standard stages of practicum activities	Experimentation activities rigid in each step
Selection of free practicum tools and materials	Can only use the tools and materials provided by the application	Must follow the tools and materials in accordance with the practicum guidelines
Students are free to design experimental activities	Design of tool and material arrangements following the application	Must follow the design of the tool according to the manual
Practicum results are not the same, depending on the tools and materials selected by students	The practical results will be the same	Practicum results tend to be the same

3. Results

3.1. MLBL Utilisation Process

MLBL is an experimental activity that can be carried out anytime and anywhere. This activity utilises the tracker software in the process of data analysis. The initial data are obtained from the selected phenomenon and recorded in video form by students. Some examples of the MLBL activity are shown in Figure 2.

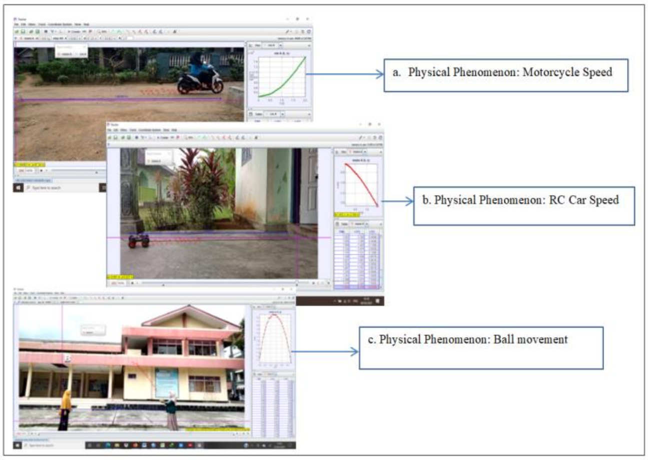
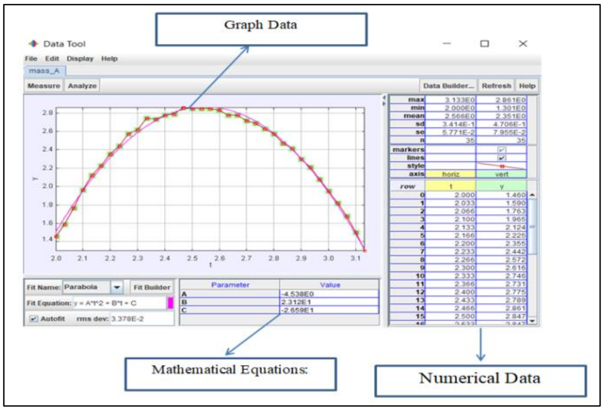


Figure 2. Examples of the mobile experiment activity

The advantage of using the software in MLBL activities compared to other types of experimental activities is the multi-representation of the data obtained. The results of the obtained experiments are in the form of graph data, numeric data and mathematical equations. An example of the results of the analysis page on the tracker software is shown in Figure 3.

The analysis shown in Figure 3 is obtained from the phenomenon of throwing the ball, as shown in Figure 2c.



Fit Name: Parabola
Fit Equation: y = A*t^2 + B*t + C
☑ Autofit rms dev: 3.378E-2

Parameter	Value
A	-4.538E0
B	2.312E1
C	-2.659E1

max	3.133E0	2.861E0
min	2.000E0	1.301E0
mean	2.566E0	2.351E0
sd	3.414E-1	4.706E-1
se	5.771E-2	7.955E-2
n	35	35
markers		☑
lines		☑
style		
axis	horiz	vert

row	t	y
0	2.000	1.460
1	2.033	1.590
2	2.066	1.763
3	2.100	1.965
4	2.133	2.124
5	2.166	2.225
6	2.200	2.355
7	2.233	2.442
8	2.266	2.572
9	2.300	2.616
10	2.333	2.746
11	2.366	2.731
12	2.400	2.775
13	2.433	2.789
14	2.466	2.861
15	2.500	2.847

Figure 3. Experiment Results’ Analysis Review

3.2. MLBL usage results on motivation and SPS

Before carrying out multivariate analysis of variance (MANOVA), the normality and homogeneity of data are first conducted. Normality uses the Kolmogorov–Smirnov test, while homogeneity uses the Levene test. The data are declared normal if Kolmogorov–Smirnov's results have a p-value of >0.05. Based on the results of the statistical test, the Kolmogorov–Smirnov obtained that all data are normally distributed ($p > 0.05$), as shown in Table 2.

Table 2. Kolmogorov-Smirnov Test Results

Dependent Variable	Group	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Motivation	MLBL	.122	30	.200*
	SimLab	.144	30	.116
	Control	.094	30	.200*
SPS	MLBL	.156	30	.060
	SimLab	.133	30	.187
	Control	.133	30	.187

Homogeneity tests are required for normal characteristic data in parametric statistical tests. The data are declared homogeneous with the Levene test if p-value is >0.05. The results of the Levene test, as shown in Table 3, show that all data are homogeneous, meaning that the data in each group have similar characteristics.

Table 3. Levene's Test Results

Dependent Variables	Levene Statistic	Sig.
Motivation	.70	.932
SPS	.975	.381

The effectiveness of MLBL implementation is found out by using motivational learning questionnaires and SPS observation sheets in each group (experimental class) in the pre-test–post-test activities; then the scores obtained by students in the pre-test–post-test activities are analysed using MANOVA. MANOVA is conducted to see the significance of differences in each class.

Based on the results of the multivariate test, as shown in Table 4, it is known that the sig value of the model implementation is significant 0.00 < 0.05, which can be interpreted as having an influence on motivation and SPS.

Table 4. Multivariate Tests Results

Effect		Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.000	.827
	Wilks' Lambda	.000	.827
	Hotelling's Trace	.000	.827
	Roy's Largest Root	.000	.827
Model	Pillai's Trace	.000	.127
	Wilks' Lambda	.000	.133
	Hotelling's Trace	.000	.140
	Roy's Largest Root	.000	.235

The test of the effectiveness of the developed model was conducted to determine the effectiveness (contribution) of treatment given to each group. The effectiveness value can be seen in the multivariate effectiveness test column of MANOVA analysis by reviewing the significance value, as well as the partial eta-squared value. The results of the effectiveness test of the model implementation against motivation and SPS through the results of the test of between-subjects effects are shown in Table 5.

Table 5. Test of between-subjects' effects

Source	Dependent Variable	Sig.	Partial Eta Squared

Intercept	Motivasi	.000	.728
	SPS	.000	.722

4. Discussion

The COVID-19 pandemic has spread to hundreds of countries around the world, changing many situations rapidly and demanding accurate and precise changes in a limited time, one of which is in the educational aspect. Indonesia as one of the countries with thousands of COVID-19-positive patients has made efforts in answering the demands of learning changes from offline to online or in the scope of distance learning (Churiyah & Sakdiyyah, 2020).

In the situation of the COVID-19 pandemic, learning activities include laboratory activities with restrictions on practicum participants (Cahyadi, 2020). The use of Phet is one of the alternative solutions in physics learning, especially in the COVID-19 situation (Suyidno et al., 2018). This is possible because Phet is a virtual laboratory-based programme that can be run online or offline (Kapilan et al., 2021). In addition, the use of motion video analysis-based software is also an alternative to practicum activities (Hockicko et al., 2015).

The MLBL model consists of several stages such as orientation, conceptualisation, investigation, conclusion and discussion. This model is applied to students' practicum activities on the topic of motion kinematics. This model also features a supporting device in the form of a module that integrates with augmented reality-based animations. The purpose of this animation is to make students understand the material better.

This study was conducted to determine the influence of the MLBL model usage on students' motivation and SPS. Based on the results of the analysis, there are differences which show that the motivation and SPS of students who use the MLBL model is better than in groups using lab simulations and lab cookbooks.

The positive impact of using laboratory activity models with the use of mobile technology is in line with the results of previous research stating that practicing experimental activities integrated with mobile phones and computers experience increased learning motivation (Cai et al., 2014; Ibáñez et al., 2014; Ince et al., 2014).

Active attitudes in the experimental groups' learning also improved significantly. The results of this study are consistent with the statement that mobile technology has a positive impact on physics instructional (Juskaite et al., 2019; Zakaria et al., 2019), including its impact on laboratory-based learning which includes developing an active attitude towards learning, enabling individual learning and strengthening motivation and cognitive knowledge (Biasi & Domenici, 2014).

The MLBL model is inquiry-based learning enabling students to utilise the surrounding natural conditions in experimental activities. The results of the research on MLBL implementation proved to produce better SPS. MLBL is a learning activity based on guided inquiry, with the help of gadgets as a learning medium. The positive results of the use of the MLBL model against students' SPS are also inseparable from the basic guided inquiry (Irwanto et al., 2018). This is in line with the view that as an effort to improve SPS needs to give assignments to students with more complex problems than just a lab cookbook. One of the recommended learning models for this is an inquiry-based laboratory project. The results of this study are also strengthened by the research of Wardani et al. (2019), which stated that experiment-based learning outside the laboratory space is effective in improving the skills of the science process.

Furthermore, with limited access to laboratory facilities, the findings of this study indicate that experimental/mobile laboratory activities based on analytical videos obtained from the physical phenomena in the vicinity can be an alternative for physics learning activities, especially in the current era of distance learning. In addition, when compared to virtual laboratories, the use of video analysis-based experiments is capable of providing better motivation and SPS. The positive results of using mobile experiments on student SPS cannot be separated from the basis of guided inquiry. This is in line with the opinion which states that as an effort to improve SPS, it is necessary to give assignments to students with more complex problems than just a lab cookbook.

5. Conclusion

The COVID-19 pandemic led to a transformation in learning. Learning that has been space-based also adopted a model cookbook and began to look for any alternative learning that allowed the desired running of practicum activities. Based on the results of the study, it can be concluded that MLBL has a significant influence on students' motivation and SPS. This indicates that during the COVID-19 pandemic, activities with restrictions, such as practical and offline activities, can be carried out with mobile activities with the MLBL model.

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