JETIA
JOURNAL OF EDUCATIONAL TECHNOLOGY INNOVATION AND APPLICATIONS

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Differences in Mastery of Physics Concepts and Learning Motivation in Groups through Online Learning Assisted by Phyphox

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ABSTRACT

E-learning is a form of distance education conducted through digital platforms. Phyphox, an application on a smartphone, is used for physics ex-periments either in class or by students at home. This application helps to do experiments without having to pay a high price. The purpose of this study was to determine the effect of Phyphox-assisted online learning on the mas-tery of physics concepts and learning motivation for class X1 students of SMAN Piyungan Yogykarta. The type of re-search is a true experiment with a posttest-only control group design. The data collection technique uses tests and questionnaires which are carried out online. The method used in data collection was the prerequisite test then continued with hypothesis testing using the MANOVA statistical test. The results showed that there was an average difference in the mastery of physics concepts and motivation to learn physics, namely, 24.8 and 173.46 in the experimental group, while in the control group, 21.88 and 171.28.

Keywords
Concept Mastery
Learning Motivation
Online Learning
Phyphox
Smartphone

Article history
Received 10 March 2025
Revised 8 May 2025
Accepted 25 June 2025

JETIA

Journal of Educational Technology Innovation and Applications

Vol. 1, No. 02, pp. 49-59

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journal.iistr.org/index.php/JETIA
DOI: 10.56741/jetia.v1i02.1167

Introduction

The current development of the world has entered the era of the Industrial Revolution 4.0. The era where changes occur in all aspects of the field that integrate technology for progress. The era where changes occur in all aspects of the field that integrate technology for progress. The impact of these changes has spread into the world of education which ultimately has an impact on technology for education. Innovation, information, the internet and maximum use of technology are the context of education today [1]. Various development devices such as computers, smartphones and internet networks are the best support for students in learning [2]. The presence of technology in the world of education forces students to be more active and take on the role of the main object in the learning process [3].

Education as a measure of the success of the industrial revolution 4.0 expects students to be able to compete globally. However, the facts on the ground show the opposite result. According to Dwi Fatmala et al. [4], the average score for the high school physics exam in 2019 was the lowest overall score for science subjects. This data is reinforced by the fact that students' scientific abilities are ranked 62nd out of 72 participating countries in the Program for International Student Assessment (PISA) survey.

Physics as a science subject is considered to have a relatively high level of misunderstanding. This causes frequent misconceptions experienced by students [5]. Lack of understanding of in-depth physics material is one of the causes [6]. Understanding the concept is very important to the final results to be achieved by students [6]. Not completing the results that have been targeted will affect learning motivation [7][8]. One of the physics materials that often experience misconceptions is collision material. Experiments using manual measurement tools will have an extensive enough error [9].

The dynamics of the problems described above are pretty complex. Therefore, to overcome these problems, learning applications are offered as experimental solutions that can be carried out in online classes. Phyphox is an application that utilizes sensors on a smartphone to be used as a measuring tool with reasonably good accuracy [10]. By taking advantage of current technological developments, Phyphox can form an online learning scheme because it has freedom of time and space and is enjoyable to do [11]. The purpose of this research is to find out the difference in the mastery of concepts and students' motivation to learn physics in classes with the application of Phyphox and classes without Phyphox in online learning. This was done to determine the effect of Phyphox-assisted online learning on students' mastery of concepts and learning motivation.

 E-ISSN 3090-7187

Literature Review

The last two decades have shown new facts that learning with online schemes is growing rapidly. Despite the pandemic being the main trigger, remote learning has long been scrutinized [12]. Distance learning, which is now better known as an online system, is at least as effective as offline learning, although this learning does not represent effectiveness for all students [13]. The good thing about online learning by utilizing today's technology is its flexible ease of use. Students can independently use the devices they have to explore in learning [8].

Several research results related to the positive impact of using online learning media are known to increase learning motivation [14]. Motivation is an impulse in a person consciously to gain benefits in the learning process [7]. Understanding all forms of learning support to maintain student motivation is important [15].

In learning physics, students can use Phyphox as an online learning tool both with the teacher and independently. The initial result that can be achieved from using this application is a better level of learning independence than when doing it with conventional methods [16]. The development of physics learning using applications has made significant progress. Many efforts have been made to facilitate the teaching and learning process in the classroom. The Phyphox application can be a good means of teaching physics [5]. Phyphox takes a role by utilizing the presence of sensors on cellphones as a tool for conducting experiments [10]. This application can perform remote experiments connected to a PC with results in the form of data or graphs in real time [17].

Hikmatiar [18] in his research has used Phyphox as a means of independent experiment. The results obtained in the study of the effect of room temperature on the tennis ball resistance coefficient are proven. So far, it is known that Phyphox produces valid and reliable data with fairly good accuracy [9]. Another test was the pendulum experiment conducted by Nanto et al. [1], he tried to do a similar practicum by comparing the use of Phyphox and conventional practicum. The final result obtained is that there is no significant difference between the two. These results are also reviewed regarding the measurement error which gets a score of 0.13%.

Materials and Methods

This research was conducted at SMAN 1 Piyungan Yogyakarta for students in classes XI MIPA I and XI MIPA II. This type of research uses quasi-experiments with a research design that uses a posttest-only control group design. The sample selection used a cluster random sampling technique, resulting in two groups, namely the experimental group, which was treated with Phyphox, and the control group without Phyphox. The number of samples was 47 students, consisting of 22 students in class XI MIPA I and 24 students in class XI MIPA II.

In the experimental and control groups, students were treated in the experimental and control groups before being given a concept mastery test and a learning motivation questionnaire. The research design can be seen in Fig. 1.

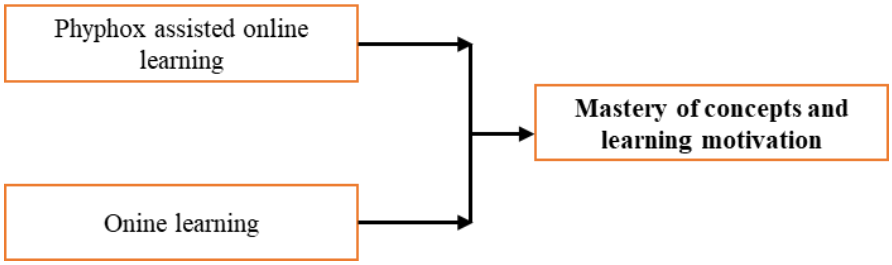


Fig. 1. Research design

The experimental design carried out in the experimental group when learning to use Phyphox can be seen in Fig. 2.

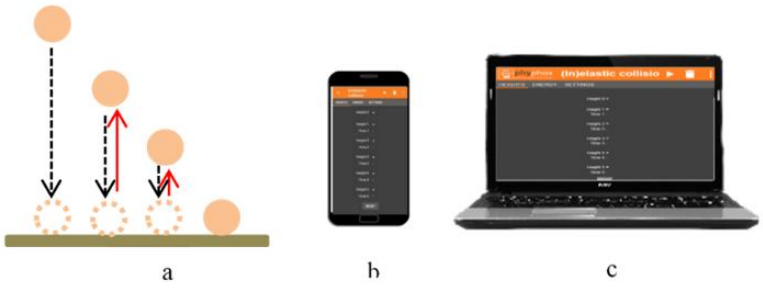


Fig. 2. (a) a ball that is inflated on a table (b) the Phyphox application on a smartphone (c) the Phyphox application on a laptop

The learning technique in this study was carried out online, and the media used was Jogja Belajar Class (JB Class). Each media was treated the same in both groups, namely class XI MIPA I as the experimental group and class XI MIPA II as the control group. JB Class is used as a learning medium that controls students online by presenting material, learning and practicum videos, assignments, and exercises, as well as concept mastery test questions. Measuring student learning motivation using a learning motivation questionnaire with as many as 47 questions consisting of 27 positive questions and 20 negative questions. The questionnaire was done online on the Google form at the link https://forms.gle/Xv32HRK81p2f9nSc8.

The learning motivation questionnaire uses the ARCS (Attention, Relevance, Confidence, Satisfaction) motivation theory. The form of questionnaire is a multilevel scale using a Likert scale with alternative answer choices for each statement item. The category and weight of the answer used is 4 if always, 3 if often, 2 if sometimes and 1 if never. A display of online learning using JB Class can be seen in Fig. 3.

E-ISSN 3090-7187

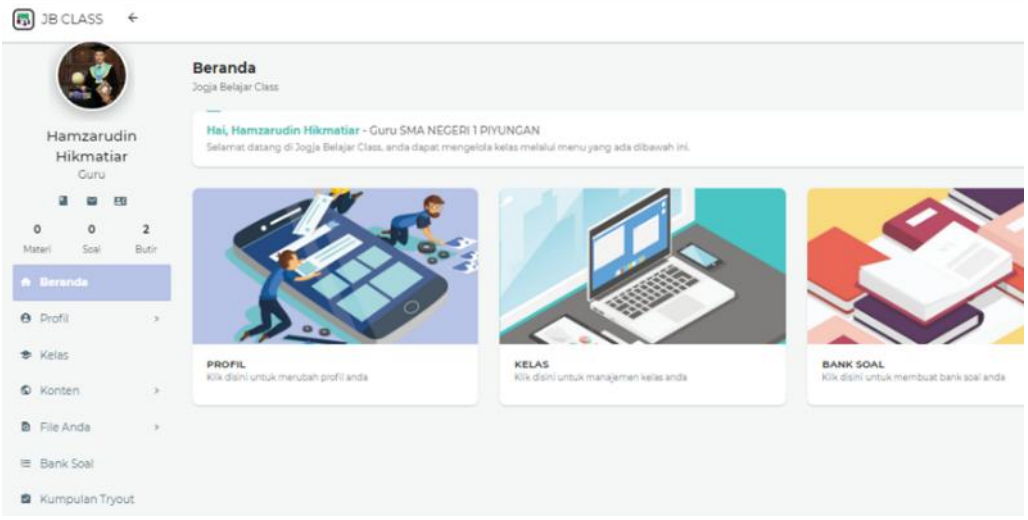


Fig. 3. Display of online learning using JB Class

The research results obtained through the concept mastery test and filling out the learning motivation questionnaire conducted by students will be collected and plotted on Microsoft Excel and then analyzed with the help of SPSS 25. The analysis used to test the hypothesis was carried out by MANOVA analysis. Before testing the hypothesis, the researcher conducted a prerequisite test by carrying out the Kolmogorov-Sminov normality test and analyzing data homogeneity using the Levana Statistical test. If the two prerequisite tests meet the requirements with sig> 0.05, then the hypothesis testing will be continued with the help of SPSS 25.

This study uses a posttest-only control group design with MANOVA analysis with the consideration that the researcher only wants to see the difference between learning groups using Phyphox and without it. This difference will indicate that there is an influence of the use of Phyphox in learning. So in the study, the researcher did not involve a pretest in the data analysis and only used a posttest to measure the difference in mastery of physics concepts and student learning motivation. The data has a difference by indicating the influence of Phyphox, if the results of the data analysis have a value with a significance of < 0.05.

Results and Disscusion

Learning that is applied to the experimental and control groupes uses online learning with the LMS, namely JB Class. The experimental group and the control group were given a different treatment, and the online learning experimental group was assisted by Phyphox, while the control group did not use Phyphox. Class display in online learning using JB Class can be seen in Fig. 4.

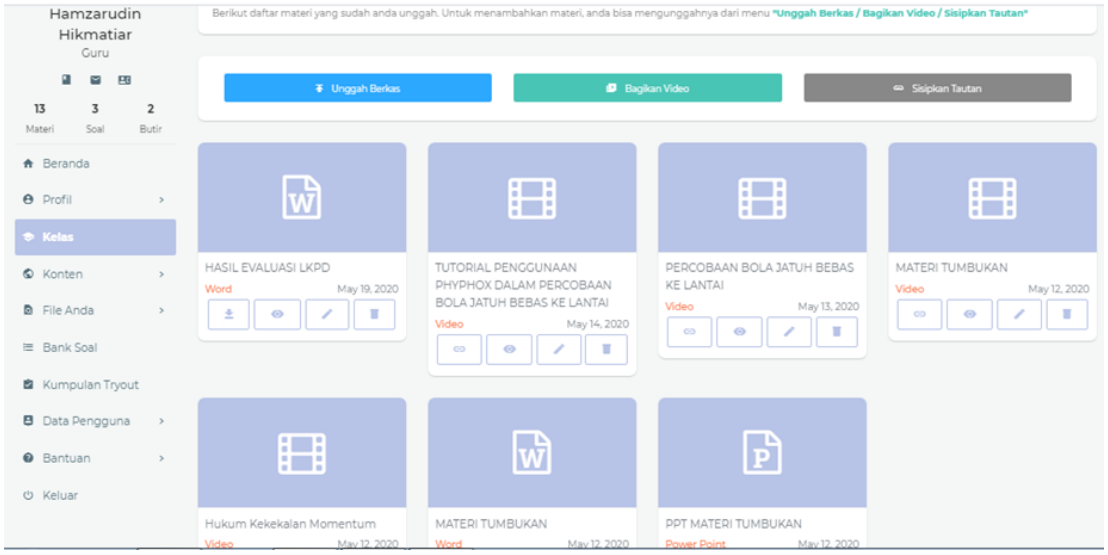


Fig. 4. Display class on JB Class

Based on Fig. 4, students are given worksheet and video experiments conducted by the teacher then students are asked to analyze the video based on the worksheet. Every student who joins the class has the same rights to access various classroom materials uploaded by the teacher. Apart from materials and assignments, a question bank menu is also available in the LMS. Questions that will be given to students as a concept mastery test will be uploaded through the menu, and students will work on these limits according to the arrangements made by the teacher.

Student learning motivation questionnaires will be given to students online, both in the experimental and control groupes, at the end of the meeting. The questionnaire was given to determine the students' motivation to study physics after being treated in their class. The results of filling out the questionnaire online by students via the Google form can be seen in Fig. 5.

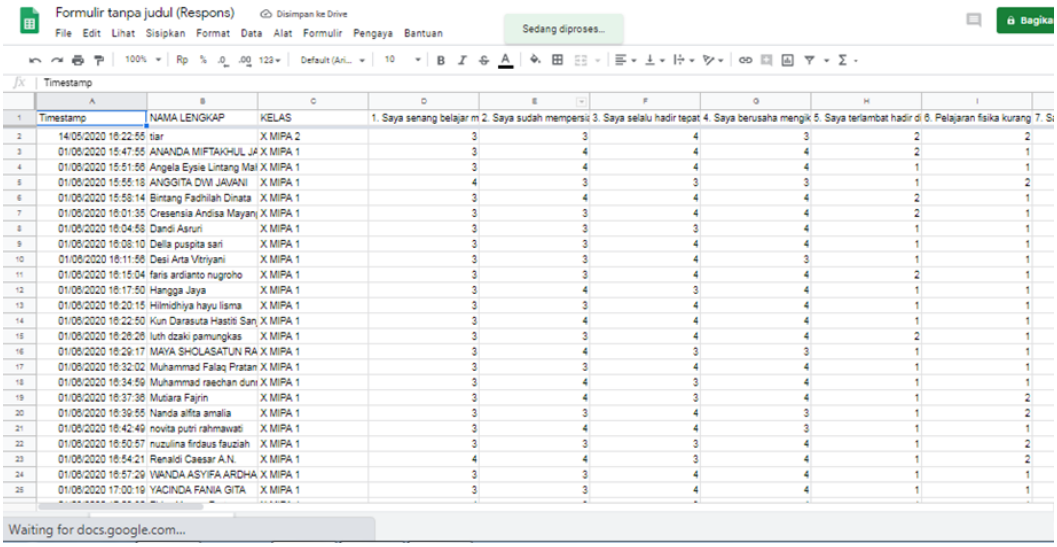


Fig. 5. The results of filling out the learning motivation questionnaire with the Google form

E-ISSN 3090-7187

The concept mastery data described is the research data using multiple choice questions with as many as 30 items. A trial to measure mastery of the concept is a test given to students after the treatment is carried out in the experimental group and control group. The test aims to determine students' mastery of physics concepts in collision material. The test results can be seen in Table 1.

Table 1. Description of the data on the results of the concept mastery test

Description	Experiments	Control
	Concept mastery	
Average	24.82	21.88
Standard deviation	2.06	1.56
Min score	20	19
Maximum score	28	25

Based on Table 1, the values of the experimental group (XI MIPA I) and the control group (XI MIPA II) have different average scores on the results of the concept mastery test. The average value of the experimental group test was 24.82, while the average value of the control group was 21.88. There is a difference in interpreting the average value of students' mastery of physics concepts between the experimental group using Phyphox-assisted online learning and the control group without using online learning alone. It can be seen that the experimental group (Phyphox) has a higher yield value than the control group (without Phyphox).

After being given treatment, in the experimental and control groupes, students were given a learning motivation questionnaire with a total of 47 questions consisting of 27 positive and 20 negative questions. The learning motivation questionnaire aims to determine the level of student motivation in taking online lessons assisted by Phyphox in the experimental and control groupes, which only apply online learning without Phyphox. The description of the data from the results of filling out the learning motivation questionnaire by students can be seen in Table 2.

Tabel 2. Analisis deskriptif motivasi belajar siswa

Description	Experiments	Control
Average	173.45	171,28
Standard deviation	2.04	2.65
Min score	170	164
Maximum score	177	175

Based on Table 2, there is a difference in the average value of the experimental and control groupes' learning motivation. Students learning motivation scores in the experimental and control groupes ranged from 170 to 177 and the average value was 173.45 for the experimental group, while the control group obtained values ranging from 164 to 175, and the average value was 171.28.

In analyzing data using MANOVA, it is necessary to carry out the Kolmogorov-Sminov normality test and analyze data homogeneity using the Levana Statistical test. The results of the normality test and homogeneity analysis can be seen in Table 3.

Table 3. Normality test of concept mastery and learning motivation

Groups	Variabel	Sig
Experiment	Concept mastery	0.092
Control		0.200
Experiment	Learning motivation	0.111
Control		0.071

Based on Table 3, the significance of the Kolmogorov-Sminov test results on data on concept mastery in the experimental group and control data for normality is more than 0.05 (Sig> 0.05), then the data is normally distributed. The normality of learning motivation in both the experimental and control groupes is more significant than 0.05 (Sig>0.05), which means that the data is normal. While the homogeneity test can be seen in Table 4.

Table 4. Homogeneity test

Variable	*Levena Statistic*	df_1	df_2	Sig (ρ)
Concept mastery	1.855	1	45	0.180
Learning motivation	1.387	1	45	0.245

Based on Table 4, the results of the homogeneity analysis using Levena Statistics show that the overall data or data distribution is homogeneous. This is because of the value of Sig. (ρ) > 0.05, which means the data is homogeneous. Based **on** the results of the data analysis prerequisite test, the data obtained for mastery of the concept and learning motivation of students in the control and homogeneous groups were normally distributed. The results of the prerequisite test fulfill the requirements for conducting hypothesis testing in research.

Hypothesis testing was carried out using MANOVA analysis with Tests of Between Subjects Effects to determine the effect of the independent variables on the dependent variable seen from differences in concept mastery and student motivation in the experimental group and the control group. Data from the results of hypothesis testing with MONOVA analysis using Tests of Between Subjects Effects can be seen in Table 5.

Based on Table 5, the significance value of mastering the concept of 0.000 is less than 0.05 (sig <0.05), while students' motivation to learn physics has the same significance value, which is less than 0.05 (sig <0.05). The results of hypothesis testing with MANOVA analysis using Tests of Between Subjects Effects showed that there was an effect of online learning assisted by Phyphox on concept mastery and student motivation in the experimental group compared to the treatment given to the control group.

Table 5. Hypothesis testing using MANOVA Tests of Between Subjects Effects

Tests of Between-Subjects Effects						
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Correcte Model	Concept mastery	101.023[a]	1	101.023	30.735	.000
	Learning motivation	55.335[b]	1	55.335	9.708	.003
Intercept	Concept mastery	25519.066	1	25519.066	7763.754	.000
	Learning motivation	1390703.165	1	1390703.165	243988.200	.000
Online learning	Concept mastery	101.023	1	101.023	30.735	.000
	Learning motivation	55.335	1	55.335	9.708	.003
Error	Concept mastery	147.913	45	3.287		
	Learning motivation	256.495	45	5.700		
Total	Concept mastery	25667.000	47			
	Learning motivation	1395580.000	47			
Corrected Total	Concept mastery	248.936	46			
	Learning motivation	311.830	46			

This difference is caused by the use of Phyphox, which is quite simple and accessible to students because it can be downloaded on a smartphone [10][18][19]. The use of this application has been carried out a lot to make learning fun and have an impact on student learning motivation, this has been tested based on several validation results of learning media by several experts [5]. Apart from using Phyphox, online learning itself has had a good impact on learning [8], but with this application's help, the practicum measurements have more precise results [1]. The Multivariate Tests test can be seen in Table 6.

Table 6. Multivariate test results

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Online learning	Pillai's Trace	.422	16.071[b]	2.000	44.000	.000
	Wilks' Lambda	.578	16.071[b]	2.000	44.000	.000
	Hotelling's Trace	.730	16.071[b]	2.000	44.000	.000
	Roy's Largest Root	.730	16.071[b]	2.000	44.000	.000

Based on Table 6, the results obtained from the multivariate analysis showed that there were differences in the mastery of physics concepts and the learning motivation of students in the experimental group and the control group, as seen from the significance value at Wilks Lambda which was less than 0.05 (sig <0.05). Learning motivation generated by implementing Phyphox-assisted online learning is caused by the use of simple and inexpensive applications in learning [18], besides that it has a positive impact on students because it increases creativity which has an impact on increasing mastery of concepts [17]. Apart from its simple use in online learning, this form of technology is very much needed. The success of online learning depends on several factors, namely the use of technology and the teacher's teaching style [20][21]. Because

technology is basically the most abundant element of online learning, including the use of smartphones for physics experiments [11][22].

Conclusion

Based on the analysis and discussion results, it can be con-cluded that the application of Phyphox-assisted online learning in the experimental group had differences in the mastery of physics concepts and student learning motivation, and the control group did not apply Phyphox to online learning. This difference can be seen in the description of the mastery of physics concepts, namely the experimental group has an average of 24.82 and 21.88 for the control group. Meanwhile, the average learning motivation of the experimental group was greater than that of the control group, name-ly 173.45 and 171.8. Based on the results of the MONOVA analysis, shows a significance value of less than 0.05 (Sig <0.05), which means that there is a significant difference between the experimental group and the control group. Differences in concept mastery and students' motivation to learn physics are influenced by the use of Phyphox in online learning. The use of Phyphox is very affordable for conducting experiments in physics learning. The application on the smartphone is easy to do and easy to get and can be used online or offline. So students can do it inde-pendently at home. What the next researcher has to do is conduct research using Phyphox on other physics materials with different outcomes.

Conflict of Interest

On behalf of Hamzarudin Hikmatiar and the team as the authors of this article, I am aware that the results of this article have no basis whatsoever. All that is stated is based on academic attitudes for education and reference.

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