The Effect of Web-Assisted Problem Based Learning Model on Physics Conceptual Understanding of 10th Grade Students

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The Effect of Web-Assisted Problem Based Learning Model on Physics Conceptual Understanding of 10th Grade Students

Raisuz Zahro*, Jumadi, Insih Wilujeng, and Heru Kuswanto
Yogyakarta State University, Indonesia

*Email : raisuzzahro23@gmail.com

Abstract. Physics learning requires a good students' conceptual understanding. One of the efforts to shape students' conceptual understanding is by using the right learning model. The purpose of this study is to determine the effect of Web-Assisted Problem Based Learning model on physics conceptual understanding of 10th grade high school students. The type of this research is quasi-experimental research. The research design was posttest only, non-equivalent control group design. The research was conducted on 10th grade students of SMA N 2 Yogyakarta, semester 2 academic year of 2017/2018. The sample in this research were 60 students. 30 students in the control class and 30 students in the experimental class. Based on the results of the Independent Sample t-Test analysis, it was found that there were differences in students' conceptual understanding between the experimental class and the control class. The average ability to conceptual understanding in the experimental class was higher than the average in control class. From the average mentioned, we can see that students in the experimental class has reached the limit of minimum completeness criteria with the good category of students' conceptual understanding. While the control class was still under the minimum completeness criteria which then categorized as less conceptual understanding students. The result of this research is, Web-Assisted Problem Based Learning Model is taking effect on physics conceptual understanding of 10th grade students of SMA N 2 Yogyakarta with a low size effect.

Keywords: Problem based learning; Learning assistance; Conceptual understanding.

1. Introduction

Physics is often regarded as a difficult subject by many people, especially high school students. This is because students do not understand the concept of physics material deeply. Students tend to learn physics by memorizing without understanding the concept of material and learning activities by solving problems without detailed understanding [1]. The low mastery of physics is because students only understand part of the concept. Students are only able to understand a number of facts related to the basic concepts of natural phenomena, have not been able to report and link various science content, let alone applying complex and abstract concepts [2]. This makes students' achievement in learning physics low.

Physics contain many abstract concepts. Ability to think abstractly is needed by students in learning abstract physical material [3]. Students with good abstract thinking skills will more easily interpret symbols and concepts into physics equations. Although many studies have examined students' conceptual understanding, the relationship between conceptual understanding and problem solving ability has not been well studied [4].

The 2013 curriculum that is currently implemented by the government focuses students on active learning. The learning paradigm has turned into a student centered and has a contextual approach. Active learning process no longer uses a standard process, but changes to a persolized (personalized?) process. In this case, problem solving skills, critical thinking, and learning how to learn are very necessary to be developed [5]. In connection with this, the development of learning tools with models and techniques that suits the needs of students needs to be done with the hope that learning objectives can be achieved.

One of the efforts to maximize learning is to use the application of Problem Based Learning (PBL) as a learning model. The Problem Based Learning model influences the concept understanding and students' creative thinking ability [6]. Problem-based physics learning has an explicit impact on students' concept mastering cognitive structures and skills [7]. Problem Based Learning must include problems and make students more active in the process, so that it is easier to accept the material learned.

Although it has many positive impacts, Problem Based Learning has some difficulties in its implementation. Allocation of learning time in every session in school is not sufficient to implement Problem Based Learning maximally. By using Problem Based Learning, students will need a long time to investigate and gather information to solve problems. Allocation of learning time at meetings in schools is not sufficient to implement maximum Problem Based Learning. Constraints in Problem Based Learning are caused by teachers who cannot convey information and inappropriate communication [8].

Problems in Problem Based Learning can be overcome by applying IT-assisted learning (E-Learning). In addition to choosing the right learning model, the use of learning media also influences physics learning [9]. The development of technology extends to all aspects and fields, including the field of education. Learning device innovations need to be done with IT assistance, one of them using the web. The quality of classroom learning can increase with web-assisted learning [10]. Learning through web can make a new breakthrough and have the opportunity to produce higher understanding and learning outcomes [11]. This web-assisted learning utilizes the internet which can easily accessed by students, wherever and whenever.

Online learning that has been known today functions as a media link between the teacher and students in the online learning space [12]. Problem Based Learning can be combined with web-assisted online learning, where the teacher can monitor the progress of the student's investigation while not in school. By using web-assisted learning, students can access information related to subject without limited space and time. With this, students are slowly trained to become independent learners. Application of web-assisted Problem Based Learning can also overcome the problem of time shortages that have occurred so far. The teacher does not need to rush to deliver the subject so that the information conveyed can be received by students optimally.

Based on the description above, this work discusses the effect of the application of web-assisted Problem Based Learning models on students' concept understanding.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method

The type of this research is a quasi-experimental research with posttest only research design, non-equivalent control group design. Quasi-experimental research serves to determine the effect of treatment or experiment on the characteristics of the subject [13]. The design in this study is shown in Figure 1.

R_E	X_1	O_1
R_C	X_2	O_2

Figure 1. Quasi Experiment Design

Where R_E is the experimental group, R_C is the control group, X_1 is the treatment with a web-assisted PBL model, X_2 is the treatment with the lecture learning model, O_1 is the posttest experimental group, and O_2 is the posttest control group.

The study was conducted on 10th grade students of SMA N 2 Yogyakarta. The population in this study were all 10th grade students of SMA N 2 Yogyakarta consisting of 9 classes. The sample used in this study amounted to 60 students. XMIA 7 as a control class as many as 30 students. XMIA 5 as an experimental class consists of 30 students. The material used in the study was Simple Harmonic Vibration in the Pendulum.

This study involves several variables grouped into: (1) the independent variable in this study is the learning model. The experimental class is treated with a web-assisted PBL model. The control class is given treatment in the form of learning with lectures; (2) the dependent variable in this study is the students' conceptual understanding; (3) control variables in this study are teachers, materials, learning objectives, assessment instruments, allocation of learning time and assessment methods.

Data collection techniques were done through test in the form of 3 items of description questions with understanding the concept of comparing and clarifying (classifiying) as indicators. In the concept comprehension test instrument, a variety of tests were carried out including validity test and reliability test using product moment correlation. Prerequisite test data analysis using homogeneity test and normality test. Data analysis test of conceptual understanding was done using the Independent Sample T-Test. To find out the influence of the Web-Assisted PBL model, the size effect was then calculated.

The general description of students' concept comprehension ability is then qualitatively assigned to each range of values [14]. The guidelines of values categorization is shown in Table 1.

Table 1. Categorizing Guidelines for Concept Understanding Value

Range of Value	Category
95-100	Satisfying
85-94	Very good
75-84	Good
65-74	Medium
<65	Less

Before testing the hypothesis, several tests were carried out, namely the normality test and homogeneity test.

2.1. Normality test

Normality testing was done to find out the normality of the data. This test was analyzed using Kolmogorov-Smirnov. Data requires to shows a significance value or probability as much as <0.05 to be called normally distributed.

2.2. Homogeneity test

While homogeneity testing is used to test whether the data variant is identical or not. Homogeneity testing using Leven's Test of Equality of Error for Variance, the data is said to be homogeneous if the significance is > 0.05. Based on the results of normality and homogeneity testing, parametric tests were carried out for two unrelated data, namely Independent Sample t-Test.

2.3. Descriptive test

Then descriptive test were conducted. Descriptive tests were conducted to determine the effect on each control class and experimental class. This test analysis is carried out with the aim of giving meaning to the results obtained. In this case, to determine the effect of web-assisted problem based learning models on students' conceptual understanding.

2.4. Hypothesis test

The research hypothesis is determined as follows: (1) Ho: μ1 = μ2: there is no effect of the web-assisted Problem Based Learning model on students' conceptual understanding. (2) Ha: μ1 ≠ μ2: there is an effect of the web-assisted Problem Based Learning model on students' conceptual understanding. The significance level determined in this study is 0.05 with two-sided testing. Decision was made by setting criteria for accepting Ho as if probability> 0.05 and criteria for rejecting Ho as if probability <0.05.

2.5. Size effect

After testing the hypothesis, if there is an effect of web-assisted Problem Based Learning models on students' conceptual understanding then an effect test is conducted. The Effect test was formulated using Cohen'd which is shown in Equation 1.

$$D = \frac{\overline{X_E} - \overline{X_C}}{Sd} \quad (1)$$

The Value of D illustrates the magnitude of the effect of the independent variables that are interpreted in the experimental group on a dependent variable. $\overline{X_E}$ shows the average value of the experimental class. $\overline{X_C}$ shows the average value of the control class. Sd shows the combined standard deviation [15]. Classification criteria for Size Effect appear in Table 2.

Table 2. Effect Size Cohen Criteria

Size	Interpretation
0,8<D<2,0	Big
0,5<D<0,8	Average
0,2<D<0,5	Small

3. Results and Discussion

This study aims to analyze the effect of the application of web-assisted problem based learning models on students' conceptual understanding by involving experimental class and control class. Experiment class is a class that is treated by using a web-assisted problem based learning model. While the control class uses lecture learning. The material used in learning is Simple Harmonic Vibration in the Pendulum. The results of this study were obtained by giving a concept comprehension test after the students followed the learning in the form of 3 items of description questions. Tests are given to the experimental class and control class. In maintaining the content validity and construct validity, the test was referred to two lecturers who were experts in their fields, while item validation was done by statistical testing. The result of understanding the concept of Simple Harmonic Vibration material tests are translated through normality test, homogeneity test, descriptive test, hypothesis test and size effect test.

3.1. Normality test

To do the normality test, an SPSS analysis is performed on the experimental class and control class. The results of the normality test in this research data are shown in Table 3.

Table 3. Kolmogorov-Smirnov Normality Test

Model	Statistic	df	Sig.
Conceptual Understanding			
Experiment	,449	30	,000
Control	,400	30	,000

Table 3 above shows the results of the normality test of Kolmogorov-Smirnov test on students' concept understanding. The results of this normality test show that the significance value or

probability of students' conceptual understanding is 0,000 both in the experimental class and the control class. This means 0,000 <0,05, so it can be concluded that the data of students' concept understanding is normally distributed.

3.2. Homogeneity test

The next test is homogeneity test. Homogeneity test was analyzed using SPSS. The homogeneity test results in this research are shown in Table 4.

Table 4. Homogeneity Test Results

	Levene's Test for Equality of Variances			
	F	df1	df2	Sig.
Conceptual Understanding Based on Mean	.023	1	58	.880

From Table 4 above, it shows the significance value of the experimental class based on the control class as many as 0.880. That means, the significance value is > 0.05. So that it can be concluded that the data variants in this study are homogeneous.

3.3. Descriptive test

After the prerequisite test in this study has been fulfilled, then a descriptive test and hypothesis test are carried out. Descriptive results in this study are presented in Table 5.

Table 5. Descriptive Test Results

Description	Treatment	
	Experimental Class (N=30)	Control Class (N=30)
Mean	75,30	59,15
Median	75,00	58,30
Elementary school	7,720	5,073
Variant	59,597	25,734
Maximum Score	100	75
Minimum Score	58	50

Based on Table 5 above, it shows that the average ability of conceptual understanding in the experimental class is 75.30, higher than the average ability of control class which is amounted as 59.15. From the average, it can be seen that students in the experimental class have reached the minimum completeness criteria limit while the control class is still below the minimum completeness criteria. This shows that the ability to understand the concepts of control class students is in poor category and the experimental class is in good category. These criteria are based on the conceptual understanding criteria in Table 1.

The comparison of conceptual understanding between students in the experimental class and the control class is shown in Figure 2.

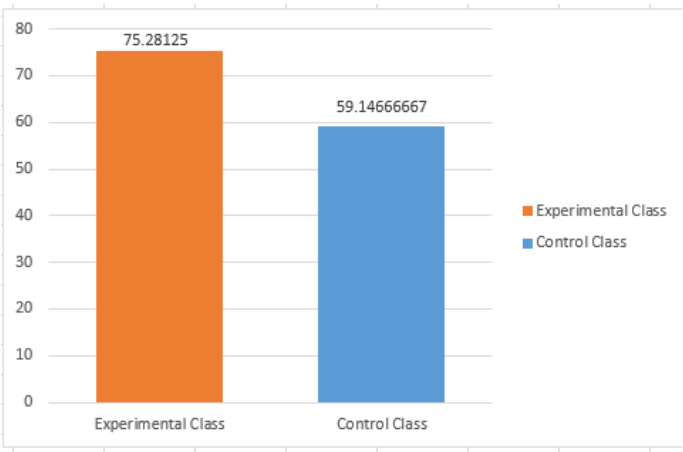

Figure 2. Differences of Students' Conceptual Understanding

From the results shown in Figure 2. it can be said that the web-assisted Problem Based Learning model is effectively used in the learning process in which delivering material about simple harmonic vibration on the pendulum in this study. The results of this study are in line with Loyens's research [16] which suggests that problem based learning can improve understanding of concepts.

3.4. Hypothesis test

After the descriptive test then the hypothesis test is carried out. Hypothesis testing is analyzed using SPSS. The results of hypothesis testing using Independent Sample t-Test analysis in this research data are shown in Table 6

Table 6. T-test Hypothesis Test Results

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Conceptual Understanding					
Equal variances assumed	9,578	58	,000	16,153	1,687
Equal variances not assumed	9,578	50,109	,000	16,153	1,687

Based on the results of the Independent Sample t-Test analysis in Table 6. above, it shows that the significance value (2-tailed) = 0,000. These results mean the significance value in this study is <0.05. So it can be concluded that Ho is rejected and H1 is accepted or it means that there is an effect of web-assisted Problem Based Learning model on students' conceptual understanding.

3.5. Size effect

Having stated that there is an effect of the web-assisted problem-based learning model on students' conceptual understanding, the size effect is calculated to see the magnitude of the influence made. Based on Equation 1. the results obtained for the size effect in this study are shown in Table 7.

Table 7. Result of Size Effect

Size Effect	**Category**
0,247245	Low

The size effect results in this study is as big as 0.247245 if categorized in Table 2. So it was said that the effect of web-assisted problem based learning model on students' concept understanding was low.

3.6. Students conceptual understanding in simple harmonic vibration in the pendulum

The material delivered in this study is simple harmonic vibration in the pendulum. Based on the results of the students' answers to the concept comprehension test of question item number 1 about the ability to compare in connection to analyzing frequency and period, it was seen that the experimental class students had higher concept comprehension skills than the control class. In the experimental class as much as 86% of students have been able to explain well that mass does not affect the frequency and period. While in the control class, as many as 70% of students still experience misconceptions, they assume that mass does affect frequency and period. The next is question item number 2 on the concept understanding test regarding the clarifying indicator. In this item, it can be seen that the concept understanding of the control class students is higher than the experimental class. In the experimental class, 83% of students experienced misconceptions. While in the control class as much as 76% of students also experience misconceptions, but can explain better than the experimental class.

Lastly, question item number 3 on the concept understanding test of factors that affect harmonic vibration in the pendulum with concept understanding of comparing as the indicator. In this point, 96% of students both in the experimental and control classes can explain well that the longer the string, the greater the period.

Some of the explanations above reveal that the application of web-assisted Problem Based Learning models influences the understanding of concepts. The results of this study are also supported by the results of Akinoğlu's study [5] who found that the application of problem-based active learning models influenced students' conceptual development positively and lessen misconceptions. Chandra's research [17] also stated that web-based physics learning has a positive impact on student learning outcomes. Intranet web physics learning effectively improves mastery of concepts but is not effective in improving students' problem-solving abilities [18]. The understanding of the concept of the experimental class students is higher than the control class. The application of the web in this learning can help students find the concepts they are learning themselves.

4. Conclusion

The results of this study, it can be concluded that the web-assisted Problem Based Learning model on the topic of simple harmonic vibration in pendulum influences the conceptual understanding of 10th grade students of SMA N 2 Yogyakarta. In this case, the experimental class using web-assisted Problem Based Learning model has a higher conceptual understanding than the control class in which using the lecture learning model. Learning with a web-assisted problem based learning model influences students' understanding of concepts in the low category. Based on the results of this study, researchers can provide some suggestions as follows: (1) the initial ability of students should be considered properly so that the implementation of learning can achieve the expected results; (2) manage the best possible time allocation, so that each phase of the Problem Based Learning model can run optimally; (3) in the use of the web as a learning medium, students should be able to access and operate the media independently.

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