LEARNING PHYSICS PBL MODEL USING CONTEXTUAL APPROACHES TO IMPROVE STUDENT *HIGHER ORDER THINKING SKILLS* (HOTs)

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Abstract

Higher Order Thinking Skills (HOTs) are the thinking skills needed in the 21st century and in the era of the industrial revolution 4.0. This research aims to describe the effectiveness of the *Problem Based Learning* (PBL) model with a contextual approach to physics learning to improve students' HOTs. This research is *Pre Experimental* by using *pre-test and post-test design*. The research sample was 86 students of class X state senior high school in Surabaya, Indonesia in the odd semester of the academic year 2019/2020. This research sample, divided into 3 (three) classes of the same experiment. Before learning physics using the PBL model with a contextual approach, all students in all three classes were given a first test (*pre-test*), and after the same study, all students in the three classes were again given a final test (*post-test*) with test material the same one. Data that has been collected is then analyzed using n-gain calculations, paired t-tests, and *analysis of variance* (Anova). The results showed that after applying physics learning using PBL models with a contextual approach, students' HOTs scores increased significantly at alpha 5%, with average n-gain categorized as moderate, and consistent (not different) in all three experimental classes. So it can be concluded that learning physics using PBL models with an effective contextual approach can improve students' HOTs. Thus, to improve students' HOTs, PBL model learning can be used with a contextual approach.

Keywords: PBL, Kontekstual, HOTs

Abstrak

Higher Order Thinking Skill (HOTs) merupakan keterampilan berpikir yang diperlukan pada abad ke-21 dan pada era revolusi industri 4.0. Penelitian ini bertujuan untuk mendeskripsikan keefektifan model *Problem Based Learning* (PBL) dengan pendekatan kontekstual pada pembelajaran fisika untuk meningkatkan HOTs siswa. Penelitian ini adalah *Pre Experimental* dengan menggunakan *pre-test* and *post-test design*. Sampel penelitian adalah 86 siswa SMA Negeri kelas X di Surabaya, Indonesia pada semester gasal tahun ajaran 2020/2021. Sampel penelitian ini, dibagi dalam 3 (tiga) kelas eksperimen yang sama. Sebelum dilakukan pembelajaran fisika menggunakan model PBL dengan pendekatan kontekstual, seluruh siswa pada ketiga kelas diberikan tes awal (*pre-test*), dan setelah dilakukan pembelajaran yang sama, seluruh siswa pada ketiga kelas tersebut kembali diberikan tes akhir (*post-test)* dengan materi tes yang sama. Data yang telah terkumpul, kemudian dianalisis dengan menggunakan perhitungan n-gain, uji-t berpasangan, dan *analysis of variance* (Anova). Hasil penelitian menunjukkan bahwa setelah diterapkan pembelajaran fisika menggunakan model PBL dengan pendekatan kontekstual, skor HOTs siswa meningkat secara signifikan pada alpha 5%, dengan rerata n-gain berkategori sedang, dan konsisten (tidak berbeda) pada ketiga kelas eksperimen. Sehingga dapat disimpulkan bahwa pembelajaran fisika menggunakan model PBL dengan pendekatan kontekstual efektif dapat meningkatkan HOTs siswa. Dengan demikian, untuk meningkatkan HOTs siswa dapat digunakan pembelajaran model PBL dengan pendekatan kontekstual.

Kata kunci: PBL, Kontekstual, HOTs

INTRODUCTION

Physics is a science that discusses the behavior, structure of objects, and the nature of natural phenomena from various elements; for example: space, physical that can be captured by the sense of sight, and sound that can be captured by the sense of hearing (Susanti & Jatmiko, 2016). When students study physics it is expected that students will be able to analyze, evaluate, and create phenomena that occur in everyday life. In other words, students are expected to be able to think at a higher level (*Higher Order Thinking Skill*), which is to think critically and creatively in solving the problems they face. High-level thinking or HOTs according to the cognitive level in Bloom's revised taxonomy, namely one's ability to reach the level of thinking analyze (C4), evaluate (C5), and create (C6) (P21, 2019; Schraw & Robinson, 2011). This is in accordance with the demands of the 21st century and the industrial revolution 4.0, namely that everything will run automatically, transparently, and also proactively (Lavalle, 2018). In the current 4.0 Industrial Revolution era, a person's ability to automatic technology has indeed been met, but the demands of the future are not only automatic, but that person must also be able to predict things that will happen, so as to avoid problems which will arise in the future. In addition, the statement is also in accordance with the demands of the 2013 curriculum, one of which is to produce students who have high-level thinking patterns (Wulandari, 2016; Schraw & Robinson, 2011).

However, in fact contrary to the expectations mentioned above, the results of the *Program for International Student Assessment* (PISA) tests in the world which were attended by 70 countries in the field of science at junior and senior high school level showed that education in Indonesia was ranked 62. Tests PISA aims to determine the ability of students to solve science problems that exist in everyday life, using high-level thinking processes obtained by students during learning in school (OECD, 2018). The average score of PISA is 493, while the average score for Indonesian students is 403. So the average score for Indonesian students is level 1 (one in the range of 340 to 440) and students can only complete assignments with complex problems low. From the PISA results it can be seen that the HOTs score of Indonesian students is still below the average score of HOTs of students of other nations.

The low score of the HOTs of Indonesian students is supported by the results of the pre-research that has been carried out at Surabaya 13 State Senior High School in the subjects of physics, work and energy materials. The mean score of students' HOTs is still relatively low, namely that as many as 95,9% of students have not yet reached the Minimum Passing Criteria score (KKM), which is 70 and only 4,1% of students have achieved the Minimum Passing Criteria score (KKM). One alternative solution to improve students' HOTs is to apply PBL learning models with a contextual approach. This is in line with the opinion of Marjan *et al*., (2014), who said that PBL is an active learning model that can increase HOTs in students. There are several advantages to applying PBL learning with a contextual approach, which is that besides being able to meet the demands of the Industrial Revolution 4.0, it can also solve problems in daily life. Likewise, it can facilitate the growth of social skills in students, this may happen because in the learning process, students can work together in a team with their peers. This statement is supported by Schmidt (2011), who said that learning PBL models can generate the ability to construct cognitive structures of processes, principles, and also the basic mechanism of a phenomenon in students, so that it can help students to solve problems with innovative solutions.

METHOD

This type of research is a Pre-Experimental study using *pre-test and post-test design*. The data obtained from this study are in the form of numbers, then the results of this study can be presented in a descriptive quantitative manner.

To find out the initial knowledge possessed by students and to find out whether or not HOTs have been achieved in students, a *pre-test* can be given before the PBL model learning is implemented with a contextual approach to the material Work and Energy. Then students are given the material Work and Energy by learning PBL models with a contextual approach. After students get Work and Energy material by learning PBL models using a contextual approach, students are given a *post-test*. This post-test is used to determine students' high-level thinking after being taught in the form of applying PBL learning models using contextual material in Work and Energy.

The data obtained in this study are quantitative data obtained from the results of the *pre-test* and *post-test* that were tested on a sample of students. In this study researchers used three classes as samples, namely in class X-5, X-6, and X-8. In this study to obtain data used test and observation methods.

Internal validity is a validation activity by experts, in this study validation was carried out by two expert lecturers in the field of physics from the Department of Physics, Surabaya State University. This internal validity

is used to validate the instruments in this study. Analysis of the results of the validation of the research instrument was carried out by means of averaging the scores of each instrument and then the validity category can be determined descriptively. An instrument can be said to be feasible to use when the category is valid at least, which has an average minimum score of 3,0 (Ahmad, 2014). In addition, the questions to be tested in the sample also need to be validated using the item validity test. An item can be said to be valid when it has a r_{count} score greater than r_{table}.

After testing the validity of the reliability test. Reliability is used to determine the level of consistency of an instrument. An instrument is said to be reliable when showing the same score when tested on the same group at different times and opportunities (Sugiono, 2015). An instrument can be said to be reliable when it has a $r_{11count}$ value greater than the r_{table} value.

The mean n-gain score analysis aims to investigate the improvement of students' HOTs in each class. The mean n-gain score is divided into three criteria, namely low, medium and high. When the mean n-gain score is less than 0,3, it falls into the low criterion. When the average n-gain score is between 0,3 and 0,7, it falls into the medium criteria. When the average n-gain score is more than 0,7, it is included in the high criteria (Hake, 1999). The application of PBL model learning with a contextual approach to the material Business and Energy can be said to be effective when there is a statistically significant increase in HOTs at alpha 5% with a mean score of n-gain of at least a medium category, which has a minimum score of 0,3 and does not differ for the three classes.

RESULTS AND DISCUSSION

A. RESULTS

To examine the data obtained from the study, analysis was carried out related to the data obtained based on the grouping of data as follows: the validity of the instruments carried out by experts, the validity of the items, the reliability of the items, and the increase in student HOTs after being given the application of PBL model learning with a contextual approach to the Work and Energy material. Prior to the research the validity of the research instrument was conducted by two expert lecturers. The results of the validity carried out by two expert lecturers are presented in the following table:

Table 1 Validity by Experts

Research Aspects	Validator 1	Validator 2	Mean Score	Criteria
Syllabus	3,7	3,7	3,7	Very Valid
RPP	3,4	3,2	3,3	Valid
LKPD	3,3	3,3	3,3	Valid
Handout	3,7	3,3	3,5	Very Valid

From "Table 1" it can be seen that the average score given by two expert lecturers as validators for the syllabus and *Handout* research aspects in the range of 3,5 – 4,0, so it can be said to be very valid. Whereas the research aspects of the RPP and LKPD are in the range of 3,0 – 3,4 so they are included in the valid criteria. In addition to the validity of the research instruments conducted by two expert lecturers, validity and reliability of the items were also carried out. The results of item validity and item reliability are presented in the following table:

Table 2 Validity dan Reliability of Items

Item of Quation	r_{count}	r_{table}	Validity	Criteria	$r_{11count}$	r_{table}	Reliability
1	0,873	0,444	Valid	High	0,90	0,44	Reliable
2	0,819	0,444	Valid	High			
3	0,689	0,444	Valid	High			
4	0,613	0,444	Valid	High			
7	0,729	0,444	Valid	High			
8	0,537	0,444	Valid	Medium			

In "Table 2" we can find out the validity of the items used to find out the validity of the items. The results of the validity of the item has a r_{count} score greater than the r_{table} score, so the six items can be said to be valid.

In addition to the item validity test a reliability test was also conducted to find out the level of consistency of the items that were declared valid. The results of the item reliability test in "Table 2" can be seen that the $r_{11count}$ score is greater than the r_{table} score, so it can be said that the valid items are reliable. Thus all aspects of research can be used because it has valid and reliable criteria.

The increase in students' HOTs can be analyzed based on *pre-test* and *post-test* scores that have been conducted using 6 item description questions. Of the 6 items referred to the HOTs indicator based on cognitive levels in Bloom's Taxonomy revised by Anderson. Where all 6 items starting from C4, C5, and C6. In this case based on the results of tests of normality and homogeneity states the population is normally distributed and also homogeneous. After the *pre-test* and *post-test* are normally distributed and homogeneous then the paired t test will then be performed. Paired t-tests were conducted to investigate differences in sample mean when pre-test and post-test. The results of the paired t test can be seen in the following table:

Table 3 Paired t-test Results

Class	N	SD	dk	t_{count}	t_{table}	Conclusion
X-5	28	104,78	27	2,980	1,703	H_0 rejected
X-6	28	141,95	27	3,004	1,703	H_0 rejected
X-8	30	80,69	29	3,980	1,699	H_0 rejected

In "Table 3" it can be seen that the t_{count} score is greater than the t_{table} score so H_0 is rejected which means the *post-test* score is higher than the *pre-test* score. *Post-test* scores that are higher than *pre-test* scores in each class mean there is a significant increase in student HOTs after being given PBL model learning with a contextual approach to the material Work and Energy.

After the paired t test was performed, the next n-gain score was analyzed in each class. The mean n-gain score was used to investigate the increase in students' HOTs in each class. The results of the average calculation of n-gain scores for each class can be seen in the following figure:

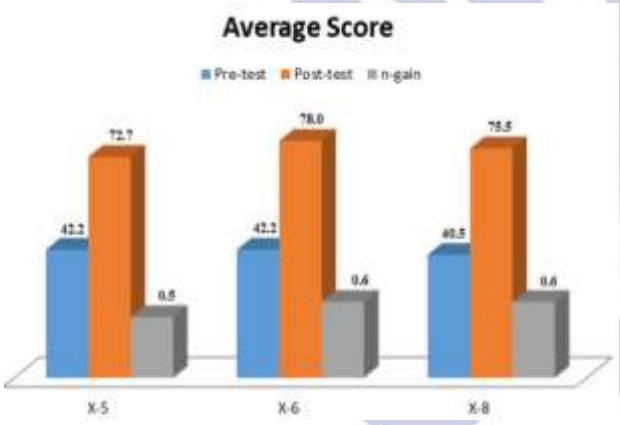

Figure 1 Average *Pre-test, Post-test,* dan n-gain Scores

In "Figure 1" it can be seen that in each class the average *post-test* score is greater than the mean *pre-test* score. In addition, each class has an average n-gain score that falls in the range of 0,3 – 0,7 so that it is in the medium criteria. In this case it can be interpreted that by doing PBL model learning with a contextual approach to the material Work and Energy can increase students' HOTs by 0,3 to 0,7 or enter in the medium criteria.

After obtaining an average analysis of n-gain scores and having gone through the assumptions of normality and homogeneity and the results meet the requirements, an ANOVA test is then performed. The purpose of doing ANOVA test is to find out whether there is a significant difference from the increase of HOTS in each class. The results of the ANOVA test at α = 0,05 can be seen in the following table:

Table 4 ANOVA Test Result at α = 0,05

Class	Average n-gain Score	N	dk	F_{count}	F_{table}	Conclusion
X-5	0,5					
X-6	0,6	3	2	0,21	3,11	H_0 received
X-8	0,6					

From "Table 4" it can be seen that the F_{count} score is less than the F_{table} score, so H_0 is accepted. H_0 is accepted meaning that there is no significant difference in the increase in HOTs of students in each class when given PBL learning models with a contextual approach to the material Work and Energy.

B. DISCUSSION

From the results of the data analysis done in "Table 3" it can be seen that the *pre-test* scores conducted before PBL model learning with contextual approaches are lower when compared to the *post-test* scores conducted after PBL model learning with contextual approaches are given. In addition, the *pre-test* score given in the sample can state that students have not been able to complete HOTs problems well, this is evidenced by the students' *pre-test* scores which are still below 50. This means that students have not been able to complete HOTs questions by more than 50%. HOTs questions are questions that refer to analyzing and evaluating a problem, even HOTs questions can also lead to creating solutions to problems. Thus students are given PBL model learning, namely learning that refers to an authentic problem. In addition, learning is also a contextual approach, which is authentic problems that are related to everyday life.

By giving PBL learning models with a contextual approach it can train students' HOTs. In this case students can learn to solve problems in everyday life by analyzing these problems. With this analysis students can summon their initial knowledge and then construct it to the existing problem. The statement is in accordance with the results of research conducted by Hali (2016) which states that the application of PBL learning models can improve students' HOTs, this is because the PBL learning model is oriented to a problem in daily life that can make students collect knowledge back previously owned. Then if students' initial knowledge cannot solve existing problems, students will try to explore other sources of information to evaluate these problems until students can create solutions to those problems. This makes students more creative in making decisions to solve a problem. The statement is in line with research conducted by Leary

(2012) and Thomas (2013) that PBL learning models can make students more creative in thinking, so that new ideas will be created that can be used to solve existing problems (Yoon, *et al*. ., 2014; Argaw, *et al*., 2017).

In learning PBL models students are divided into several small groups, this can make students easier to find information related to the knowledge needed to solve these problems. Thus the division of the group helps students in gathering knowledge to make solutions to existing problems. This is consistent with the results of research from Schmidt (2011) which states that small groups also help to increase HOTs in students because students in groups can arrange knowledge in order to solve an existing problem. The problem orientation given in PBL model learning can increase students' HOTs because students are encouraged to construct knowledge through a process, principles, and also the basic mechanism of a phenomenon that can help students to find solutions to a given problem.

In addition, in learning PBL models with a contextual approach, students are given an experiment. In this case students begin to match the knowledge they have with the results of the experiment. From the results of experiments that are not in accordance with student knowledge makes students think more about aligning it. This is in line with research conducted by Prayogi (2019) where when students feel something is wrong it can stimulate students to think critically by analyzing these errors. So it can be said that the PBL learning model can reach all the indicators that exist at a higher level of thinking. From the experiments given in the PBL learning model students can get a concept and then relate it to the existing problems to create a solution for solving those problems. Thus students not only memorize or apply the concepts of Work and Energy, but students can analyze, evaluate, and even create solutions to existing problems related to Work and Energy material.

Thus the PBL learning model with a contextual approach can stimulate students to develop the basic knowledge they have. The syntax in the PBL model is in line with higher-level thinking indicators or HOTs according to the cognitive level in the revised Bloom taxonomy, starting from C4 (analyzing), C5 (evaluating), and C6 (creating). When you see the paired t test results that have been done it can be said that there is an increase in students' HOTs after PBL model learning is done with a contextual approach to the material Work and Energy. To find out how big the increase can be seen from the analysis of the average n-gain score. In the results of the analysis of the average value of n-gain in each class, namely classes X-5, X-6, and X-8 are in the range of 0,3 to 0,7, meaning that the average results of the n-gain values in each - each class is in the medium category. So that it can be said that the increase in students' HOTs on Work and Energy material has moderate criteria. The results of this study are in line with research that has been conducted by several researchers about the effect of PBL on students' HOTs (Kim, 2017; Dwi *et al*., 2013; Jailani *et al*., 2017; Kek & Huijser, 2011). The results of the research of these researchers stated that PBL is one learning approach that can stimulate the ability of students to think at a high level and oriented to problems in daily life.

From the data analysis it can be seen that the paired t test at $\alpha = 0{,}05$ has a t_{count} score greater than the t_{table} score so H_0 is rejected with the meaning of the test score after being given PBL model learning with a contextual approach is greater than the test score before it is given PBL model learning with a contextual approach. Besides that, through the analysis of the mean n-gain score, there was an increase in students 'HOTs in the range of 0,3 – 0,7 so that in this case the increase in students' HOTs could be categorized as medium criteria and the results of the ANOVA test with $\alpha = 0{,}05$ stated that the increase in HOTs in each class there is no difference or it can be said that the application of PBL model learning with a contextual approach to the material Work and Energy can provide the same results in each class. Thus the PBL model learning with a contextual approach to improve the HOTs of class X students of Surabaya 13 State Senior High School on Work and Energy material can be declared effective.

CONCLUSION

From the results of data processing and analyzing the data in this study it can be concluded that the application of PBL model learning with a contextual approach to the material Work and Energy is declared effective in increasing the HOTs of students. This is because the results of the study obtained a statistically significant increase in students' HOTs at alpha 5% with a mean score of n-gain in the medium category, which has scores in the range of 0,3 – 0,7 and is not different for the three classes.

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