Effectiveness of Project-Based Learning to Improve Students' Ability to Solve Problems

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Abstract: The purpose of this study is to assess the effectiveness of student solving abilities through the use of project-based learning.This study has used quasi experiments with the design of nonequivalent control group design.Instruments of the study using a student-solving ability test consisting of pretest and posttest, were analyzed using a quantitative approach. Inferential analysis using independent-sample t-test has shown that there is a significant difference in student's ability to solve between the treatment class and the control class. It can thus be concluded that the use of project-based learning can improve student solving abilities on static fluid topics.

Keywords: Project-based learning, problem solving ability, static fluid

1. Introduction

Physics which is part of science deals with phenomena or problems in everyday life. The development of science and technology demands that the world of education be able to make changes in the form and strategies of teachers in the implementation of teaching and learning. This is so that students not only repeat the ideas they have learned but the student must be able to explore the ideas he has gotten(Depdiknas, 2006). Formal education at this time tends to get stuck just dwelling on remembering which is a low order of thinking(Hamalik, 2008). This kind of activity has the potential to create a decline in potential students, even though every child is created with extraordinary potential.This situation causes students not to be able to solve problems creatively(Iwan Sugiarto, 2014).Problem solving ability is seen as a fundamental part of science learning(Gok&Silay ,2010; Brad.A, 2011).

Problem solving ability requires a specific skill and ability that each student has, which may be different between students in solving a problem.Problem solving ability refers to the effort that students need in determining the solution to the problem they are facing(Selcuk, Caliskan. S, Erol. M,2008). Gok and Silay (2010) has stated that problem solving ability is the ability of students to use existing information to determine what must be done in certain circumstances.

The level of problem solving according to Creswell, et al (2008), is (1) confrontation of the problem that is feeling a difficulty. This process is marked by being aware of a situation unclear. (2) defining the problem, which is clarifying the characteristics of the situation. This stage includes activities to identify what is known and unknown, find goals, and identify standard and extreme conditions. (3) dictating several solutions. This stage can include activities to pay

attention to patterns, identify steps in planning, and choose or find algorithms.(4) the consequences of the alleged solution, which is to plan a suspected solution. Like using an existing algorithm, collecting additional data, conducting a needs analysis, reformulating the problem, trying for similar situations, and getting results. (5) testing the consequences of testing whether the problem definition matches the situation. This stage can include evaluating whether the hypothesis is appropriate, whether the data used is right, whether the analysis used is right, whether the analysis is in accordance with the type, whether the results make sense, and whether the plan used can be applied to another.It is important for students to be able to identify the elements that are known, what is being asked, and the adequacy of the elements needed to solve the problem (Windari et al, 2014). Wimbey and Lochhead (1984) have described the characteristics of good problem solving, namely, (1) solving problems that either have a strong belief that issues can be resolved through prudence and in-depth analysis. (2) good problem solvers are very concerned about the overall facts in issue. (3) good problem solving learns that analysis of complex problems and ideas is done by dividing these ideas into small steps. (4). Good problem solving tends to work on problems from beginning to end with careful steps. (5) good problem solving tends to be more active when facing problems.Selcuk, et al (2008) have explained indicators of problem solving abilities including: (1) understanding problems, (2) planning solutions, (3) solving problems, (4) checking.

There are several factors that influence students' problem solving abilities. According to Ogunleye. A. O (2009), students cannot solve problems including the lack of physics books that are used as references and inadequate physics learning modules. Recognizing the importance of students' problem solving abilities, it is necessary to make efforts to improve physics learning, including innovating in learning using appropriate learning approaches so that students can practice their thinking skills.Students need to be trained to solve problems that provide opportunities to explore their abilities to express ideas or strategies in solving problems.One of the learning that provides opportunities for students to find solutions to problems in various ways is learning based on the Project or known as project based learning (PjBL).PjBL is a learning that regulates learning through certain projects (Thomas, 2000). Projects are tasks given by the teacher based on challenging questions or problems, involving students in designing, problem solving, giving decisions, or investigating activities, giving rights autonomously over a period of time to gather and integrate new knowledge based on students' experiences in activities in real(Yunianta, Rochmad & Rusilowati, 2012).PjBL is learning that gives freedom to students to plan learning activities, carry out projects collaboratively, and ultimately produce work products that can be presented to others. The opportunity to present, listening to the ideas of others, and reflect on their own ideas on others, is a form of individual learning. An interactive process with peers helps the process of knowledge construction. From the perspective of this theory project-based learning can help students improve collaborative problem solving abilities (Moore, 2000).Abidin (2007) has explained that PjBL's superiority is being able to develop various basic skills that students must possess including thinking skills, decision-making skills, creativity skills, problem-solving skills, and at the same time are seen as effective for developing students' self-confidence and self-management. This learning emphasizes student activities in solving various open-ended problems and applying their knowledge in working on a project to produce a particular authentic product.

Helm and Katz (2011) have stated that project-based learning can deeply explore the values of a particular topic that students are studying. The main keyword of this learning is the existence of research activities that are deliberately carried out by students by focusing on efforts to find answers to questions posed by the teacher. From the above opinion, we can conclude that Project Based Learning is a learning process that directly involves students to produce a project.

Basically this learning develops problem solving ability in working on a project that can produce something.

Diffily and Sassman in Abidin (2007) have explained that this learning has the following seven characteristics:
a. Engaging students directly in learning
b. Connect learning with the real world
c. Implemented with research based
d. Involve various learning resources
e. Unite with knowledge and skills
f. Done from time to time
g. End with a certain product.

In connection with the above characteristics, the Ministry of Education and Culture in Abidin (2013) have explained that project-based learning has the following characteristics.
a. Students make decisions about a framework.
b. Problems or challenges raised by students.
c. Students design the process to determine the solution to the problem or challenge proposed.
d. Students are collaboratively responsible for accessing and managing information to solve problems.
e. The evaluation process is run continuously.
f. Students regularly reflect on activities that have been carried out.
g. The final product of learning activities will be evaluated qualitatively.
h. The learning situation is very tolerant of mistakes and changes.

The purpose of this study is to assess the effectiveness of student solving abilities through the use of project-based learning.Through this research, it is expected to provide benefits, including (1) as an exercise for independent learning and hone problem-solving ability, (2) For teachers, as an alternative learning strategy to train students' independence in learning and achieve maximum learning outcomes, (3) For schools, as one of the inputs in improving the quality of student learning in schools.

2. Methodology

This research has been carried out in SMA Negeri 5 Pekanbaru in class XI consisting of 36 students in the treatment class and 36 students in the control class. The time of the study was conducted in the 2018/2019 school year. The population in the study were 142 students of class XI MIPA.The research that has been done is quasi experimental design research. The design used in this study is nonequivalent control group design (Sugiyono, 2017). In this design the sample was taken from the population then grouped into two, namely the treatment group and the control group. The treatment class will be applied to project-based learning, while the control class is applied to conventional learning. Then proceed with the provision of pretest and posttest to the treatment class and the control class.The instrument used to collect data in this study is a test of students' problem solving abilities on the topic of static fluid. The results obtained from this test will be analyzed using descriptive analysis and inferential analysis. Inferential analysis that has been done is used to determine differences in students' problem solving abilities after applying project-based learning in the treatmentclass and applying conventional learning to the control class through hypothesis testing that applies to the

population. Before testing the hypothesis first a prerequisite test is carried out, namely the normality test and homogeneity test. The data used for normal and homogeneous tests are pretest data before being given learning treatment and posttest data after learning. If the data obtained is normally distributed and homogeneous then hypothesis testing for pretest data and posttest data with concluding criteria are as follows:If significant, $p > 0.05$ then H_0 accepted the meaning there is no significant difference between the treatment class and the control class.If significant, $p < 0.05$, H_0 is not acceptedit means there are significant differences between the treatment class and the control class.

3. Result and Discussion

Quantitative approaches were conducted to answer all study questions. The following illustrates the quantitative analysis of the results of the study conducted.

Table 1. Descriptive data for pre test problem solving

	Problem solving ability	
	treatment class	control class
Mean	22.206	18.202
Standard deviation	9.720	8.520
Minimum	4.60	3.10
Maximum	45.40	36.90
Number	36	36

Based on table 1, students in the treatment classhave a higher average value than the control class with a difference in standard deviations that are not too large. Data normality can be seen in table 3.2. Based on the significant normality test in the pre test shows $p > 0.05$, which means that both collections are normally distributed.

Table 2.Kolmogrov Smirnov Pre-Test of Problem solving skill

	Statistic	dF	Sig
Treatment class	0.93	36	0.200
Control class	0.101	36	0.200

Before starting learning, a pre-test was conducted in both classes to see whether there were significant differences between the treatment class and the control class. obtained $F = 1.164$, ($p > 0.05$) in Levenes's Test for Equality of Variances which states the value of the homogeneity of the two classes where the results of the static pretest that has been tested to the treatmentclass and the control class have the same or homogeneous variance. The requirement to apply a model or strategy using two classes as a research class, the sample data must have the same variance or both homogeneous classes. Independent sample t-Test test results at pretest obtained $t = 1.585$, ($p > 0.05$). These results indicate that H_0 is accepted, meaning that there is no significant difference between the treatment class and the control class before learning, so that both classes are feasible to take action, where in the treatment class project-based learning models and control classes with conventional learning are implemented.

Table 3. Descriptive data for post test problem solving

	Problem solving ability	
	treatment class	control class
Mean	51.97	40.01

Standard deviation	13.94	12.61
Minimum	24.60	16.90
Maximum	80.80	62.30
Number	36	36

Based on table 3 it can be seen that the treatment class is superior to the control class. Standard deviation after treatment is smaller than at pretest. Higher results are in the treatment class. When learning using project-based learning and conventional learning is complete, the treatment class and the control class will be given a posttest with the same questions as the pretest, only the problem is randomized. The results of the posttest will be analyzed using inferential analysis by conducting an independent sample t-test. The results of the homogeneity of the two classes can be seen directly in the output of independent sample t-test (levenes's test for equality of variances from the homogeneity of variances test) with a significance value of F = 0.004, p = 0.953 (p> 0.05) which means treatment class posttest data and the control class has the same or homogeneous variance.

The t-test carried out is to test the hypothesis H_0. Based on the output of independent sample t-Test, it was obtained t = 3.817, p <0.05. These results indicate that Ho is rejected, meaning that there are significant differences in problem-solving abilities between classes that apply project-based learning to classes that apply conventional learning to the topic of static fluid with a 95% significant level. Inferentially the application of project-based learning can improve students' significant problem solving ability, meaning that the increase in the treatment class as a sample can also occur and apply to the population.

Table 4. Profile of Student Problem Solving Indicators

	Treatment class	Control class
Understanding the problems	32.08	22.57
Troubleshooting planning	41.67	30.74
Problem solving implementation	68.61	57.04
Interpretation	72.13	55,56

The problem solving phase aims to find out basic knowledge and students' ability to understand the problem. Indicators at this stage can be achieved if students know the physical quantities of the topic of Static fluids that have been explained in the learning process. Students are required to be able to identify: the information provided by the problem, the information asked about the problem, whether the information provided is sufficient, what conditions (conditions) must be met, and restate the problem in a more operational form (can be solved) (Atma, 2010) . Indicators of understanding problems are lower than other problem solving indicators. This is due to the lack of students' knowledge of physical quantities and concepts that must be used to solve static fluid problems so that it is difficult for them to change data to be more operational. Another contributing factor, according to Depdiknas (2002), is that students lack language skills. Language skills in solving problem solving problems can be interpreted as the ability to translate questions.

The stage of problem solving planning aims to determine the ability of students in planning problem solving. Indicators at this stage are students can produce new information and express problems with pictures, symbols or tables as organized into a plan (Atma, 2010). According to Depdiknas (2002) this is because some students lack the ability to use the scheme. Students cannot change problem information into certain image patterns due to not knowing the concept.

Furthermore, some students are less able to make strategies (Depdiknas, 2002), so it is wrong to determine the formula that must be used in solving problems.
The problem solving phase according to the plan aims to find out the abilitystudents in carrying out problem solving after determining how to solve it. Indicators at this stage students are able to provide the final answer by calculating the numbers by using formulas that have been determined at the stage of problem solving planning (Atma, 2010). At this stage it is needed the ability to create algorithms, which emphasize the completion or work of the question. Students must use appropriate mathematical abilities (numeracy) to make conclusions (Depdiknas, 2002). Problem solving indicators are higher than other indicators. This is caused because in Project Based Learning directly involves students in designing a project, problem solving, decision making, or investigation. In accordance with the theory of constructivism by Piaget, that knowledge will be shaped by students if students with objects / people and students always try to form an understanding of these interactions (Rifai & Anni, 2011). This also has an impact on increasing the interpretation indicator or re-examining the problem-solving ability to increase.The indicator at the re-examination stage is that students are careful in re-examining whether the answers they have received are correct from the stage of understanding the problem, planning the problem solving and implementing the solution according to the plan made. Then make conclusions from the final answers they get from the calculation results.

4. Conclusion

Based on the research that has been done, it can be concluded that through the application of project-based learning can improve students' problem solving abilities. Project-based learning is an effective way to improve students' ability to solve problems. There are significant differences in student learning outcomes between classes that use project-based learning with conventional classes. The implementation of project-based learning can be used on other different physics topics and different levels of education to improve the quality of education in the future and to change conventional learning patterns into more creative learning patterns. Based on research results obtained, it can be recommended several things, namely: (1) Assessment of other high-level thinking skills such as creative thinking skills need to be done through project-based learning. (2) the use and development of project-based learning tools to be more optimized in other physics concepts to be more meaningful.

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