The effect of project based learning on learning environment and learning outcomes in vocational high school students

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Abstract. The aimed of this study was to determine the effect of Project Based Learning Models on students’ learning environment and learning outcome in vocational High School. Samples were taken using cluster random sampling technique. This study used quasi-experimental method and involving a population of 142 students in the first year in automotive class from one of State Vocational High School in Surakarta. The sample was taken using cluster random sampling. Automotive class A with 36 students was used as the experimental class and automotive class B with 35 students as the control class. Data was collected using questionnaire, interview and test in the topic of rectilinear motion and circular motion. Data were analysed using descriptive and inferential analysis techniques using ANOVA. The results of this study showed that there was significant effect of project based learning model on students’ learning environment and outcomes. The project-based learning and learning environment has an interaction to determine the students learning outcome. Students tend to have better learning outcomes in good learning environment. Project-based learning successfully increases the learning environment significantly on indicators teacher-student relationships and Student-student relationships.

1. Introduction

Education is one of the important elements to improve the quality of human resources in order to be able to face the globalization and 21st century era [1]. In line with the Law of the Republic of Indonesia Number 20 of 2003, regarding National Education System, Chapter 2 article 3 stating that National Education functions to develop capabilities and shape dignified national character and civilization in order to educate the nation's life, aiming at developing students' potential to become human beings who have faith and devotion to God Almighty, noble character, health, knowledge, competency, creativity, independent and become citizens of a democratic and responsible state.

Therefore, the education process must lead to intellectual development, skill development, and attitude formation. These three aspects are the direction and purpose of education that must be sought. Schools as the frontline for realizing national education goals, especially the vocational high schools must prepare students to improve intelligence, form attitudes and develop skills and equip students to pursue higher education in accordance with the interests and talents of students.

One of the implementation of the 2013 curriculum concept at Vocational High Schools is on Physics subjects. The Physics subject is one of the adaptive subjects in Vocational Schools which aimed to equip students as the basis of knowledge about natural science and serve as a basic requirement for students in mastering the competence of their chosen expertise program. The preliminary study on vocational
high schools obtained that the average score of Physics lessons is still below the passing grade. Through interviews and questionnaires that have been distributed to students, 76.67% of students admitted that they were happy when Physics learning in the classroom involved the activity of students and 68.17% of students felt bored when Physics learning still used the lecture method and teacher centered learning. As many as 61.29% of students still consider Physics is difficult so that students are less enthusiasts in learning Physics. Lack of teacher’s attention in adjusting to student characteristics, the material presented with the learning method used in Vocational School is the reason why Physics is a difficult lesson for students to understand and learn.

In the learning process, there are two influencing factors namely internal and external factors [2]. External factors that influence learning outcomes include learning models and learning environments. The researcher used the project based learning model to be implemented in K13-based Surakarta N 5 Vocational High Schools. This is in accordance with the opinion [3] where the learning model recommended for the 2013 curriculum among others is project-based learning. Baran & Maskan [4] suggested that project-based learning can help students become active in seeking knowledge, collecting data, analyzing, and drawing conclusions. In line with this is the opinion [5] that project-based learning combines learning experience into a context.

Other external factors that influence learning outcomes are the learning environment. According to Fraser [6], the learning environment created by teachers connects the results between cognitive and affective aspects and their perceptions of class characteristics. This is reinforced by Mainhard, et al [7] that the perception of students in the classroom is an important indicator in the social climate in the classroom. Their perspective is the most appropriate source for knowing their daily learning environment. In accordance with this, learning Physics in the classroom should involve students actively where the learning process is student-centered. Scott, et al [8] explains that student-centered learning can help students interact with their environment. Besides that, it can train students to solve a problem, and the method used is in accordance with the character of the subject so that the learning climate of Physics in the classroom becomes fun, comfortable and not boring for students.

Based on some of these explanations, the aimed of this study was to determine the effect of Project Based Learning Models on students’ learning environment and learning outcome in vocational High School.

1.1. Learning environment

Learning is a lifelong activity. Therefore, environmental factors are very important to help the learning process. In addition, the learning environment can play a role in the personal development of children in their personal and cultural environments and fields of learning. Quality learning environment is important in shaping the emotions and attitudes of students towards fellow friends, teachers, subjects they learn and the education system as a whole [9]. The learning environment is also one of the important factors that influence the achievement of increasing student learning outcomes. Learning outcomes will increase when the learning environment feels comfortable. In addition, a conducive learning environment can stimulate learning and limit negative behavior among students.

The concept of classroom climate is a process created as a result of joint activities that occur in the educational environment, namely the class [10]. This means that this concept includes matters relating to the personal characteristics, social, education and culture of students found in the educational environment and the various circumstances that occur in the class as a result of interactions between teachers and students, among students and between professions and subjects learned. Based on Zedan’s research [9] there are five analysis factors to identify the learning environment namely (1) satisfaction and enjoyment, (2) teacher-student relations, (3) gender and tension inequalities (4) student relations and (5) competitiveness.

Regarding the learning environment of vocational students, a model that is in accordance with the 2013 curriculum is used and the character of vocational students is a project based learning model in the learning process. Hugerat [11] defines project based learning as a learning model that regulates learning
around projects. It can be said that the learning model is a model that organizes learning using projects provided.

1.2. Project based learning
Thomas [112] defined a project as a complicated task based on challenging questions or problems, involving students in learning design, problem solving, decision making, or investigative activities; giving students the opportunity to work relatively independently for long periods of time; and producing real or presentation products.

Project based learning is focused on questions or problems that encourage students to experience and strive for the main concepts and principles of a topic to be studied. Project definitions for students must be made to fit the relationship between the activity and the underlying conceptual knowledge. This is usually done by encouraging questions or problems. Questions asked by students, such as activities, products, and performances must be arranged in the service of intellectual goals.

Rusman [13] suggests that the steps of project based learning are as follows: 1) start with the essential question; 2) design a plan for the project; 3) create a schedule; 4) monitor the students and the progress of the projects; 5) testing the outcome; 6) evaluate the experience. Implementation of the project based learning model follows following the six main steps in table 1.

| No | Steps                  | Teachers’ Activity                                                                                                                                   | Students’ Activity                                                                                     |
|----|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| 1  | Set the theme of the project | Asking problems and setting the theme of the project with students.                                                                                | Understanding the teacher’s explanation, expressing the opinions/ideas of the problems asked by the teacher, studying the topics to be selected and investigated as desired. |
| 2  | Set the learning context | Giving the freedom to the students to form study groups and helping in group work arrangements                                                       | Making small groups, determining steps for completion, and arranging work programs.                    |
| 3  | Plan activities         | Facilitating students in finding tools and materials for practice, supporting with the relevant books and internet access.                         | Looking for sources needed to practice and preparing tools and materials according to the theme.        |
| 4  | Process activities      | Accompanying students directly or indirectly during the investigation process.                                                                     | Conducting investigations, collecting data, and analysing data.                                        |
| 5  | Apply activities to complete the project | Determining the report framework, guiding students, assess report results, and providing positive feedback.                                        | Concluding, compiling a written report, and presenting the results of the report.                       |

2. Methods
This study used quasi-experimental method and involving a population of 142 students in the first year in automotive class from one of State Vocational High School in Surakarta. The sample was taken using cluster random sampling. Automotive class A with 36 students was used as the experimental class and automotive class B with 35 students as the control class. Data was collected using questionnaire,
interview and test in the topic of rectilinear motion and circular motion. Data were analyzed using descriptive and inferential analysis techniques using ANOVA. By this research, it was expected to improve the learning environment and learning outcomes in Physics with project-based learning models.

3. Results and discussion

3.1. The results of the research
Based on the interviews that have been conducted, it is found that students experience difficulties in learning physics. In addition, the data showed that the learning model used by the teacher was direct instruction model, discussion and assignment. Therefore, students tend to be bored and less interested in Physics learning. When the project based learning model was applied, it is expected to affects the student learning environment and student learning outcomes.

Student learning environment data was obtained from questioner that consisted of 62 statements. Five indicators of the learning environment are used in the questioner according to Zedan [9], namely 1) satisfaction and pleasure; 2) teacher-student relations; 3) gender and tension inequality; 4) student relations; 5) competitiveness. The results of the student learning environment data for the control and experimental classes presented in table 2.

Table 2. Comparison of students’ perception toward learning environment in experimental and control classes.

| Indicator                        | Experimental class (n = 36) | Control class (n = 35) |
|----------------------------------|-----------------------------|------------------------|
|                                  | Mean Standard deviation     | Mean Standard deviation|
| Satisfaction and enjoyment       | 38.67 4.64                  | 35.4 4.79              |
| Teacher-student relationships    | 64.27 5.48                  | 59.4 5.34              |
| Gender and tension inequalities  | 24.41 4.57                  | 24.22 4.45             |
| Student-student relationships    | 51.36 6.80                  | 47.45 6.38             |
| Competitiveness                 | 27.19 4.05                  | 27.37 3.14             |

The Histogram of the student learning environment of the experimental class (project) and the control class (non-project) is shown in figure 1.

![Figure 1. Comparison of students’ learning environment.](image-url)
Based on figure 1, it can be explained that students who study Physics using project-based learning are significantly more satisfied and enjoy than students who study using non-project based learning. This is indicated by data from satisfaction and enjoyment indicator, the mean of experimental class is higher than the mean of control class. For teacher and student relations indicator, the experimental class has mean value better than control class, with mean value of 51.36 compared to 47.45. This is because in the use of project-based learning, students are required to interact with each other, work together, design, and make projects, therefore the relationships between students increase. For competitiveness indicator, the experimental group and the control group has no significant difference.

The statistical description of the learning environment in the experimental class and the control class is presented in table 3. Table 3 show the mean value of the overall learning environment of the experimental class is higher than control class. The experimental class has mean value 212.57 and the control class has mean value 199.94. This indicated that the experimental class learning environment that used project-based learning is better than the control class with non-project learning.

| Statistics     | Control class | Experimental class |
|----------------|---------------|--------------------|
| Mean           | 212.57        | 199.94             |
| Median         | 214           | 199                |
| Standard Deviation | 20.06      | 15.75              |
| Variance       | 402.55        | 248.17             |
| Maximum        | 263           | 225                |
| Minimum        | 176           | 166                |

Multiple choice questions with 30 items were used to obtained learning outcome data. The instrument has been validated by experts and tested to student in order to find out the validity, reliability, difficulty level, and discriminant power. The results of student learning outcomes in the experimental and control classes are presented in table 4.

| Statistics     | Experiment class (project) | Control class (non-project) |
|----------------|----------------------------|----------------------------|
| Mean           | 74.88                      | 69.96                      |
| Median         | 73.3                       | 70                         |
| SD             | 10.03                      | 12.47                      |
| Variance       | 100.67                     | 155.60                     |
| Max            | 96.6                       | 93.3                       |
| Min            | 50                         | 43.3                       |
Table 4 showed the mean of learning outcomes in the experimental class higher than the mean value of the control class. It is indicated that Physics learning by using project-based learning is better than using non-project based learning. The standard deviation in the experimental class is smaller than the standard deviation in control class. It is indicated that the variance test scores in experimental class are smaller than control class.

A prerequisite test is conducted to determine the normality and homogeneity of data. The data obtained was normal and homogeneous; the analysis was continued by hypothesis testing. A summary of the results of the ANOVA is shown in Table 5.

**Table 5.** Tests of between-subjects effects.

| Source                     | Type III Sum of Squares | df | Mean Square | F     | Sig. |
|----------------------------|-------------------------|----|-------------|-------|------|
| Corrected Model            | 1398.31                 | 3  | 466.10      | 3.98  | 0.011|
| Intercept                  | 341952.49               | 1  | 341952.49   | 2920.63 | 0.000|
| Model                      | 721.21                  | 1  | 721.21      | 6.16  | 0.016|
| Learning environment       | 389.80                  | 1  | 389.80      | 3.33  | 0.073|
| Model * Learning environment| 635.88                  | 1  | 635.88      | 5.43  | 0.023|
| Error                      | 7844.47                 | 67 | 117.08      |       |      |
| Total                      | 381943.69               | 71 |             |       |      |
| Corrected Total            | 9242.78                 | 70 |             |       |      |

Note: Dependent variable: Learning outcomes. R Squared = 0.1512 (Adjusted R Squared = 0.113)

Table 5 show that the sig value of model used is 0.016 (< 0.05). It can be inferred that there are differences in learning outcomes between the models used. In learning environment, the Sig value is 0.075 (> 0.05). It can be conclude that there is no learning outcome difference between learning environment. This result is caused by a learning environment that increases in both models, but based on the mean value of students in the experimental class is greater than the control class. The interaction between model and learning environment has sig value 0.023 (< 0.05). It is indicated that there are interaction between models used and learning environment to determine learning outcome.

### 3.2. Discussion

Assessment of student learning environment was conducted using questioner before the treatment, while the assessment of students’ learning outcomes conducted after the treatment in the topic of rectilinear motion and circular motion. The treatment in experimental class was used the project-based learning model. This model is expected to help students to get many opportunities to be active, innovative, and creative. Therefore the learning process in the classroom is more effective for students.

The results of the study found that the learning environment using a project-based learning model is better than the learning environment by using a non-project learning model. The mean value of the learning environment in the experimental class is higher than the control class. The results of these studies are in accordance with Mainhard et al. [7]. It is stated that the environmental factors are very important to help the learning process.

In addition, the learning environment can play a role in the personal development of children in their personal and cultural environments and learning fields. A quality learning environment is important in shaping the emotions and attitudes of students towards fellow friends, teachers, subjects they study and
the education system as a whole [9]. The learning environment is also one of the important factors that influence the achievement of increasing student learning outcomes. Learning outcomes will increase when the learning environment feels comfortable. In addition, the conducive learning environment can stimulate learning and limit negative behavior among students [7].

The learning difficulties data obtained from experimental class are reported that students’ has no significant difficulties in the learning process. In addition, the learning environment in experimental class is increased. This is indicated that project based learning model increasing the learning environment and decreasing students’ difficulties in learning Physics. The students tend to be more active in learning; it is significantly improve the relationship between teachers and students. This result is in line with Hao et al. [14], which stated project-based learning can increase familiarity between peers and teacher.

The teacher has an active role as a facilitator and motivates students to design, create and present projects. Teacher has to provide appropriate guidance and direction to students. This is in line with the opinion that teacher controls the project process by actively involving students in the selection of topics, assigning roles in activities, organizing groups, choosing places, and timing of implementation [15].

However, if there is no cooperation between the teacher and the student, there is no mutual trust and respect, this process increasing tension between students and teachers which leads to failure in the education process. The teacher guides students towards better educational achievement, and improve relations with students through improving classroom behavior or cultivating a comfortable learning environment in the classroom. Therefore, students enjoyed the learning process in the classroom. Positive classroom learning environments tend to lead to better learning outcomes [16]. In line with that, the implementation of appropriate project based learning can produce better learning that is achieving higher competencies, attitudes, abilities, knowledge, and skills competently [17].

The implementation of project based learning model in the experimental class require students to carry out investigations using various scientific methods, observation in the real environment and conducting experimental tools. This activity can increase students' passion and attitude in Physics learning. Other research also developed projects in the real world with project based learning [5]. The focus of learning includes project planning, technical evaluation, analysis of results and interaction between project implementers and project material providers. The project-based learning requires modeling situations such as in real life, therefore can apply their knowledge and skills during learning activities.

4. Conclusion

The results of this study showed that there was significant effect of project based learning model on students’ learning environment and outcomes. The project-based learning and learning environment has an interaction to determine the students learning outcome. Students tend to have better learning outcomes in good learning environment. Project-based learning successfully increases the learning environment significantly on indicators teacher-student relationships and Student-student relationships. The implication of this study is that improving the learning environment is needed in physics learning to improve students learning achievement.

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