The Effect of Project Based Learning Towards Student Achievement in Electrical Machines and Energy Conversion Subject

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Abstract. The purpose of this study was to reveal the project-based learning model with conventional learning models of student learning outcomes. This type of research was quasi experimental research design. Quasi experiments used post-test only design with two random groups for experimental and control classes. The sample in this research was 64 students. The instrument used to measure student learning outcomes is a multiple choice objective test with five option. Data were analyzed using t test. The results of data analysis showed that there were significant differences in the learning outcomes of Electrical Machine and Conversion Energy subjects that were significant between students in the experimental class taught using the project based learning learning model for students in the control class taught by conventional learning models. The average value of experimental class is 82 is higher than the average control class is 73. Based on the above two learning activities, it can be concluded that using the project based learning model further improves students learning outcomes in Electrical Machine and Conversion Energy subjects compared with conventional methods of learning.

Keywords: Project Based Learning, Learning Outcomes, Electrical Machine and Energy

1. Introduction

Education is a means to develop human ability to think creatively and actively. Active learning process will encourage students to increase their cognitive creativiry. Through this process, students are expected to be able to take conclusion, to understand and to apply the theories learnt in their daily life, so an applicable learning model is needed to help students enhance their psychomotor ability. Learning process can also be known as outdoor or indoor activity in which the teacher and the students get along together. According to [1], learning process is a sequence of activities which occurs at the central nerve of somebody who is learning. Meanwhile, Sagala [2] argues that learning is a two-way communication process in which teaching is carried out by the teacher and learning is done by the students. The development of learning communication among students occurs in many education levels; one of them is in technical and vocational education. Technical and vocational education is about applied science and technology which is in line with the mastery of practical skill, attitude, and understanding toward occupational related knowledge of any economic sector. One of Vocational education is Vocational High School. According to Jalinus [3] Vocational High School is to provide students to have productive competence in any occupational world.
Based on observation conducted in Mechanical Engineering department of Vocational High School No.1 Padang, the learning process tended to be monotonous and less conducive. It was assumed that the teacher has not used the various teaching method. The tendency of teacher in using lecturing method made students less active to participate in the learning process and it resulted in teacher centered activity. During the theoretical session, teachers were less active in giving questions to students so that students felt bored and paid less attention to the material presented by the teacher. Another phenomenon in the learning schedule for X grade students was at noon when students felt sleepy, daydreamed, used gadget and chased their friends during the learning session. As a result, they got low scores and unachieved the minimum achievement criteria. The minimum achievement criteria of Vocational High School No.1 Padang are 80. The data showed that 40.63% of 96 students (39 students) passed the minimum achievement criteria, while 59.37% of them (57 students) did not (Source: Teacher of Electrical Machines and Energy Conversion subject of Vocational High School No.1 Padang). It became the school’s concern because they are prepared to face industrial world. The less active students got involved in learning activity, the less team working they had in solving the problems or doing a project. The lacks of group discussion and enhancing the knowledge were considered as factors affecting students’ low learning outcomes.

Based on the data above, some problems identified as the causes of students’ low scores are: 1) the learning methods have not varied; 2) the uninteresting learning material so that students pay less attention; 3) the learning process is teacher center; 4) students get low score of the subject; 5) students are less accustomed to working in a team. Therefore, Project-based learning can be used in Electrical Machines and Energy Conversion subject. Wena [4] defined Project-based learning as a learning model which provides teacher to conduct the class by involving project activity. Moreover, Sani [5] stated Project-based learning as long-term learning activity involving students to design, create and present products to solve real world problems. In sort, Project-based learning is a learning method which actively involving students with some projects to enhance their critical thinking to solve real world problems.

The project which will be made by the students is to make a simple electrical circuit. The circuit consists of a simple electric circuit parallel and simple electric circuit series. Equipment and materials for the project are very easy to get, as well as easy and practical to use. The simple electric circuit will be created on top of plywood board measuring 40 cm and 30 cm. The tools of simple electric power projects are LED lights, battery 12 V, small cables, tape, button batteries, scissors, sandpaper, and the electric circuit breaker. Thus, the learning activities that involve students directly can influence learning outcomes to achieve the standard of competence expected.

This study is limited to the effect of Project Based Learning (PjBL) model toward the learning outcomes. There were some reasons to choose PjBL. Harmer and Stokes [6] explained that the main advantages of Project Based Learning identified from the literature include: claims of improved academic results, the development of wider skills, increased student motivation and enjoyment, enhanced outreach and engagement beyond academia and advantages for lecturers. These will be discussed in turn below before attention is turned to the challenges of the approach. A study Prasetya [7] showed that there was an effect of implementing PjBL toward students’ learning outcomes of computer numerical control subject of Mechanical Engineering department in State University of Padang. So, this is the underlying reason for implementing Project-based learning in this course. The formulation of the problem in this study was whether there is the effect of PjBL model and conventional learning models toward students' learning outcomes in Electrical Machines and Energy Conversion subject at Vocational High School No.1 Padang.

2. Methods
This study is an experimental research using quasi-experimental design. According to Montgomery [8], the quasi-experimental is appropriate design to control the existing conditions or variables which cannot be done strictly. The study has been conducted at Vocational High School No.1 Padang for 7 weeks. The population was 96 students of X grade of Mechanical Engineering department of Vocational High School No.1 Padang enrolled in the academic year 2017/2018. Samples were taken randomly.

The results obtained X TP-C as the experimental class and X TP-A as the control class. The data of this study was quantitative data. The data source was primary data. According to Sugiyono [9], the primary data sources provide data to data collectors. The instrument in this research was multiple
choice test. According to Suharsimi [10] test is a series of questions or exercises and other tools used to measure the skills, knowledge, intelligence, ability or talent possessed by individuals or groups. The given test was a post-test. Before the test was used to collect the data, it should be evaluated. The evaluation test includes test of (1) validity, (2) reliability, (3) difficulty index, (4) discrimination power, and (5) the functioning distractors. Validity test results by using the correlation point biserial indicated that there are three invalid items, the item 4, 9, and 12. The results of reliability test using Kuder Richardson formula 20 (KR-20) obtained reliability coefficient of 0.854.

After obtaining the test results, the data were taken to create the hypotheses. Before testing the hypothesis, examination requirement analyses of data were conducted. Thus, it can be concluded from the test evaluation that 3 items could not be used. The data, then, were collected by using this test.

The next examination requirement analyses include: 1) Normality Test performed by using the Kolmogorov-Smirnov test that has been programmed in SPSS 16; 2) Test of homogeneity of variance performed by using the test of homogeneity of variances formula [9]. 3) Hypothesis testing performed by using t-test two unrelated independent variables (independent sample t-test). The purpose of testing two independent variables is to distinguish whether the two variables are the same or different.

3. Results
The data of this study were about students’ learning outcome of experimental class by using Project based learning and control class by using conventional learning. These data were attained through test. They were analyzed to determine the mean, median, mode, deviation standard, variants, the highest scores, and the lowest scores. The learning outcomes of experimental class thought by using Project-based learning were: the lowest score was 75; the highest score was 96; mean were 83.72; median was 84; mode was 80; standard deviation was 5.78 and variance was 33.39. The learning outcomes of control class thought by using Conventional learning were: the lowest score was 75; the highest score was 96; mean were 83.72; median was 84; mode was 80; standard deviation was 5.78 and variance was 33.39. Before conducting the hypothesis test, the normality and homogeneity test were carried out to meet the examination requirements analysis. The results of the normality test of the learning outcomes of the experimental class using the project based learning (A1) model were obtained by Asymp. Theig values were 0.729 and the control class using the conventional learning model (A2) was obtained asymp. The value values were 0.673. Asymp. The values of the variables are bigger than $\alpha = 0.05$. It is normally distributed and distributed to the population. The homogeneity test results obtained F count $= 1.31 < Ft = 2.38$. Thus the data is homogeneous. Hypothesis of this study was there are different learning outcomes of Electrical Machines and Energy Conversion subject of X grade students learning by Project-based learning and conventional learning. By using SPSS version 22., the result of hypothesis test can be seen in table 1.

Table 1. The result of hypothesis test

| Levene's Test for Equality of Variances | Equal variances assumed | Equal variances not assumed |
|----------------------------------------|-------------------------|----------------------------|
| Test for Equality of Means | F | .104 | |
| Sig. | .749 | | |
| t | 5.229 | 5.229 | |
| df | 34 | 33.388 | |
| Sig (2-tailed) | .000 | .000 | |
| Mean Difference | 10.833 | 10.833 | |
| Std. Error Difference | 2.072 | 2.072 | |
| 95% Confidence Interval of the Difference | Lower | 6.623 | 6.620 |
| Upper | 15.044 | 15.045 | |
It can be tailored for table 1 that $t_{\text{count}}$ was 5.229, $t_{\text{table}}$, with $df = n - 2$ was 34 and level of significance was 2.03. Because $t_{\text{count}} > t_{\text{table}}$ (5.229 > 2.03) and P value was 0.000 > 0.005, Ho was rejected. It meant there were differences between the average score of class $A_1$ and that of class $A_2$. The mean score of class $A_1$ was 83.72 and that of class $A_2$ was 72.89, so the average score of class $A_1$ was higher than that of class $A_2$.

4. Discussion
Based on t-test of experimental class and control class, in which $t_{\text{count}}$ was 3.611 and $t_{\text{table}}$, with $\alpha$ was 0.05 and $df = 34$, was 2.03224 ($t_{\text{count}} > t_{\text{table}}$), it can be concluded that learning outcomes of experimental class was better than those of control class. Ho was rejected and Ha, that there are differences of learning outcomes of Electrical Machines Energy Conversion subject of X grade students of Vocational High School No.1 Padang by using Project-based learning and Conventional learning, was accepted.

This study showed an increase learning outcomes after the implementation of project-based learning in X grade of Mechanical engineering C. Students have become more active and critical in the learning process in the classroom, either individually or in groups to find answers based on knowledge, understanding, skills that have been owned previously. Meanwhile, in the implementation of the conventional methods in the learning process, the teacher explained the material in sequence in order to help students learn the material given. Then the students were given the opportunity to ask questions and taken notes. Then, the teacher gave a topic to discuss in the group and discussed together by asking some students to write down the answer on the board. At the end of the lesson, the teacher helped the student to take a look at the material that has been studied and then assigned homework. At the time of learning activities took place, students simply sat quietly and paid attention to the teacher or friend. This condition was a dilemma of the teacher because it was difficult to know the students' understanding, especially students who do not understand tended to shy to ask. This learning situation tended to create passive students in the learning process so that the intelligence of students do not develop optimally. This condition also made the students unmotivated to follow the learning, less steeped in the concept and was difficult to develop thinking skills. This can lead to poor performance of student learning in these subjects.

Rajesh Kannan et.al [11] point out that PjBL, in comparison to other instructional methods, has value for enhancing the quality of students' learning in the subject matter areas, leading to the tentative claim that higher-level cognitive learning skills via PjBL are associated with increased capability on the part of students for applying for those learning in the novel, problem-solving contexts. Their learning outcome with the adoption of project-based learning is a positive effect on learning outcomes [12][13][14][15][16]. Further Goodman and Stivers [23] explain that research studies have demonstrated the PjBL can: (1) be more effective than traditional instruction in increasing academic achievement on annual state-administered assessment tests, (2) be more resultant than traditional instruction for teaching mathematics, economics, science, social science, clinical medical skills, and for careers in the health occupations and teaching, (3) be more practical than traditional instruction for long-term retention, skill development, and satisfaction of students and teachers, (4) be more serviceable than traditional instruction for preparing students to integrate and explain concepts, (5) be especially effective with lower-achieving students, (6) improve students' mastery of 21st-century skills, such as critical thinking, communication, collaboration, creativity, and innovation, and (7) provide fruitful models for the whole school reform.

Project-based learning provides an opportunity for students to explore the content with will use a variety of meaningful ways, and conduct collaborative experiments. This model is an in-depth investigation on a topic of the real world; it would be valuable for the attention and effort of learners. This model can be regarded as the concept of "Production-Based Education" developed in Vocational High Schools. As an institution whose function is to prepare graduates to work in business and industry, this school must be able to equip learners with "standardized competencies" required to work in their respective fields. Learning through "production-based" vocational learners is introduced to atmosphere and the true meaning of work in the world of work. Thus the learning model that is suitable for Vocational High School is a project-based learning.

In implementing project-based learning, there will be some obstacles such as: (1) project-based learning requiring a lot of time to solve complex problems, (2) many parents of students who feel disadvantaged, because it adds cost to enter the new system, (3) many instructors are comfortable
with the traditional classroom, where the instructor plays a central role in the classroom. This is a difficult transition, especially for instructors who have limited knowledge about technology, (4) The amount of equipment to be provided, so that the demand for electricity increases.

Other challenges in implementing PjBL can be about: (1) Taking on the constructivist approach; (2) Curriculum and selection of topic; (3) Management and design in project-based learning; (4) Assessing the project-based learning; and (5) The nature of collaboration. According to Tamin and Grant (2010), teachers perceive that PBL can bring many advantages to the learning experience of the students; however, as they implement it in the classroom, they may face certain challenges and they need to adjust reviews their teaching accordingly. As with any teaching method, PBL can be used effectively or ineffectively. At its best, PjBL can be the spark in engaging learning experience and create a context for a powerful learning community to promoting achievement, self-mastery, and contribution to the community [23].

Project-based learning is also beneficial for students and teachers. Not only increasing learning outcomes, but students are also able to move from novices to experts in the domain of knowledge [17], their critical thinking abilities, their presentation skills, their communication skills and their ability to work effectively on also a team are enhanced [18] [19], and students value the fact that projects are situated in their real-life contexts [20]. Meanwhile, Movahedzadeh et.al. [21] claim that with use of the PBL method, students showed improvement in the areas of self-confidence, lab technical skills, and interest in STEM-related fields and, most of all, the students showed a high level of performance and satisfaction. The benefits of PjBL for teachers are explained by Kannan [11] that for teachers, additional benefits include enhanced professionalism and collaboration among colleagues, and opportunities to build relationships with students [22]. Additionally, many teachers are pleased to find a model of that accommodates diverse learners by introducing a wider range of learning opportunities into the classroom. Teachers find that students who benefit the most from Project-based learning tend to range to those for whom traditional instructional methods and approaches are not effective.

Therefore, the results of this study may have implications that Project-based learning has been able to make a positive contribution in improving student learning outcomes, so that this model can be an alternative creative learning and innovative in improving the quality of education, especially in the subjects of Electrical Machines and Energy Conversion. There are several considerations for choosing teaching methods including learning objectives, materials/learning materials, and students. Linkages methods with the aim of learning the method is a way to achieve the learning objectives, so what methods will be used heavily influenced by the conditions of their own learning purposes. The learning objectives related to the ability to be owned students after completion of the learning activities.

In connection with the learning material to the determination of the method, it is essentially a continuation of the influence of the learning objectives. Learning material consists of concepts, principles, procedures and facts or reality. Each type of learning materials that have the level of difficulty consists of a base, continuation, and height. Based on the diversity of learning materials are then charged with their selection and use of methods in learning activities that correspond to the type of learning material. In connection with the student, it may have some diversity. For participants who have simple limited experience, it would be another way of learning when compared with those who already have a lot of experience studying the material in the same study. Therefore, the diversity of learners’ conditions resulted in the need for election and appointment of teaching methods to be used. Project-based learning can be in accordance with instructional materials, student, and learning objectives so that the average score of learning outcomes was 83.72. Therefore, Project-based learning can be used as an alternative for teachers in providing instructional Electrical Machines and Energy Conversion subject at Vocational High School No.1 Padang.

5. Conclusion

Based on the results of research and discussion for Electrical Machines and Energy Conversion subject, it can be concluded that there is a difference in the average results of X grade student of Mechanical Engineering department at Vocational High School No.1 Padang between classes which used model project-based learning earning on average 82 and classes which used
conventional learning earning an average of 73. This means that the learning outcomes of students learnt with project-based learning is better than those who learnt by using conventional learning. It is suggested for teachers who will implement the learning model of project-based learning to consider time because it takes a long time to student to achieve expected learning outcomes, and it also requires the skills of a teacher in determining the project to the students, so teachers can choose the project in accordance with the learning objectives to achieve.

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