

Improving Electric Motor Learning Outcomes with Problem-Based Learning at SMKN 2 Ternate

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Abstract— The background of this research is because the learning outcomes of Electric Motors at SMKN 2 Ternate are not maximized. The hypothesis is that if a problem-based learning method is applied, it can improve learning outcomes in electric motor lessons in class XI students of SMKN 2 Ternate. This study uses two research methods, namely quantitative and descriptive qualitative research. It collects data in this study through observation of test questions to determine learning outcomes. The test result data is in pre-test and post-test scores to determine student learning outcomes. This research includes classroom action research which is carried out to improve electric motor learning and increase student participation in learning. The results of observer observations that have been carried out on students from the first cycle to the second cycle are an increase in each cycle; namely, the average of the first cycle is 61.69. Then the results increased in the second cycle to 72.78, with 31 students in class XI TITL 2 SMKN 2 Ternate. That means classroom action research that uses problem-based learning methods on Electric Motor subjects in class XI TITL 2 can improve student learning outcomes.

Keywords: problem-based learning, learning outcomes, electric motors

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I. INTRODUCTION

The success of the learning process cannot be separated from the ability of teachers to develop learning models that are oriented towards increasing the intensity of student involvement effectively in the learning process. The development of the suitable learning model aims to create learning conditions that allow students to learn actively and with fun to achieve optimal learning outcomes and results.

Using a suitable learning model can encourage the growth of students' enjoyment of the lesson and increase motivation in doing assignments, making it easier for students to understand the lesson to achieve better learning outcomes (Datundugon et al., 2021). It is essential always to remember that no one learning strategy works best for all situations. Therefore, teachers are required to have a comprehensive understanding and be able to make rational decisions when the time is right to implement one or several strategies effectively (Killen, 2009).

In formal education such as schools, educational success can be seen in student learning outcomes in their learning outcomes. The quality and success of student learning are strongly influenced by

the ability and determination of the teacher to choose and use learning models.

The learning situation of students in SMK Negeri 2 Ternate, the learning activity level is still low. It can be seen in participating in learning in electric motor installation subjects majoring in electrical power installation engineering, TITL so that it can affect student learning outcomes in electric motor installation subjects. The minimum completeness criteria (KKM) becomes an obstacle for students majoring in electrical power installation engineering (TITL). This problem occurs because the learning used is less effective in improving student learning outcomes at SMK Negeri 2 Ternate City.

The problems that will be studied in the research are focused on applying problem-based learning models in improving student learning outcomes, and the research material is limited to understanding the types of components and characteristics of electric motors, with sub-focus: (i) application of problem-based learning model; (ii) student activities in electric motor installation lessons, the material for understanding the types and characteristics of electric motors in class XI of SMK Negeri 2 Ternate City; (iii) the application of

problem-based learning models to improve student learning outcomes.

The purpose of this research is to improve the learning outcomes of Electric Motor Installation and improve the material to understand the types and characters of electric motors in class XI of SMK Negeri 2 Ternate City through the application of problem-based learning models.

Problem Based Learning (PBL) is a learning approach that begins with presenting problems designed in contexts relevant to the material being studied (Rorimpandey et al., 2022). Problem-based Learning uses various kinds of intelligence needed to confront real-world challenges and the ability to face everything new and existing complexities (Rohmah, 2015). Problem Based Learning is a learning approach that begins by confronting students with problems. With all their knowledge and abilities, students are required to solve problems rich in concepts (Tildjuir et al., 2021).

PBL is used depending on the objectives to be achieved, whether it is related to (i) mastery of multidisciplinary knowledge content; (ii) mastery of process skills and heuristic disciplines; (iii) learning problem-solving skills; (iv) learning collaborative skills; and (v) learn broader life skills. When the objectives of PBL are broader, the problems become more complex, and the PBL process requires a longer cycle (Laili, 2019).

The purpose of using the Problem-Based Learning model is that students can think critically about a problem, solve problems independently, and find solutions to these problems (Kurama et al., 2021). Students are also expected to be able to find various solutions to the problems faced so that students understand the problems at hand.

The characteristics of problem-based learning, namely: posing a problem or question; linkages with various disciplinary problems; authentic investigation; producing and exhibiting the results/works; and collaboration (Engriyani et al., 2019). There are three main characteristics of problem-based learning, namely: (i) a series of learning activities; (ii) learning activities are directed at solving problems; and (iii) problem solving is done using a scientific thinking approach (wina sanjaya, 2008).

An electric motor is a device for converting electrical energy into mechanical energy. A device that works the other way around, converting mechanical energy into electrical energy, is called a generator or dynamo. Electric motors can be found in household appliances such as fans, washing machines, water pumps, and vacuum cleaners. In an electric motor, electric power is converted into mechanical power. This change is done by converting electric power into a magnet known as an electromagnet. As

we know that the poles of the same name magnet will repel, and the poles of the unlike attract. So we can get motion if we place a magnet on a rotating axis and the other magnet in a fixed position (Radita, 2013).

Types of electric motors that exist today are of various types and types. All electric motors have two main parts, namely the stator and rotor. The stator is the stationary part of the electric motor, and the rotor is the moving (rotating) part of the electric motor. Electric motors are distinguished from the type of working voltage source used (Radita, 2013).

The working mechanism for all types of motors is generally the same. An electric current in a magnetic field will exert a force. If the current-carrying wire is bent into a loop, then the two sides of the loop, i.e., at right angles to the magnetic field, will experience forces in opposite directions. The pair of forces produces torque (torque) to rotate the coil. Motors have several loops on the armature to provide a more uniform rotational power, and the magnetic field is generated by an electromagnetic array called the field coil (Radita, 2013).

It is essential to understand what a motor load means in understanding a motor. Load refers to the output torque (torque) according to the required speed. Learning problems are a problem for every human being; by learning, humans acquire skills and abilities to form attitudes, and knowledge increases. So learning outcomes are accurate results achieved by students to master physical and spiritual skills at school, which are manifested in report cards every semester.

To find out the progress to which someone in learning has achieved the results, an evaluation must be carried out. To determine the progress achieved, there must be criteria (benchmarks) that refer to predetermined goals so that it can be seen how much influence teaching and learning strategies have on student learning success. Student learning outcomes for most people mean tests, exams, or tests. The test's purpose is to obtain an index for determining student success (Winarno, 2015).

Learning outcomes are behavioral changes that occur after participating in learning following educational goals in the cognitive, affective, and psychomotor domains (Purwanto, 2011). The cognitive domain is classified into the ability to memorize, understand, apply, analyze, synthesize, and evaluate. In the affective domain, learning outcomes include levels of acceptance, participation, assessment, organization, and characterization. At the same time, the psychomotor domain consists of the level of perception, readiness, guided movements, accustomed movements, complex movements, and creativity.

The solution to the problem-solving problem contains four steps of completion: understanding the problem, planning a solution, solving the problem according to the plan, and re-checking all the steps that have been done (Csernoch, 2017). The first phase is understanding the problem. Without an understanding of the given problem, students may not be able to solve the problem correctly. After students can understand the problem correctly, then they must be able to develop a problem-solving plan. The ability to do this second phase depends on students' experience in solving problems. In general, the more varied their experiences, the more creative students plan to solve a problem. If a problem-solving plan has been made, then the problem-solving is carried out according to the plan that is considered the most appropriate. Furthermore, the last step is to check what has been done starting from the first phase to the third completion phase. In this way, various unnecessary errors can be corrected again so that students can reach the correct answer according to the problem given.

The development steps are carried out, among others, by improving learning outcomes. The quality of education in schools is determined by various factors, including teachers, students, the learning process, the environment for learning facilities, and infrastructure and time. One of the efforts that teachers can make is to use problem-based learning methods (PBL) to study hard and find learning concepts independently and efficiently.

Using problem-based learning methods (PBL) in order to improve learning outcomes of Electric Motors in class XI students of SMK Negeri 2 Ternate city, learning is emphasized on the process aspect, and teachers are no longer a monopoly on the learning process so that there is student involvement to be active in the teaching and learning process itself. It needs to be emphasized in the student learning process, and it is necessary to research the learning problems teachers face in Electric Motor lessons in class XI TITL students at SMKN 2 Ternate City.

This research hypothesizes that if the problem-based learning method (PBL) is applied, it can improve learning outcomes in electric motor lessons in class XI students of SMK Negeri 2 Ternate city.

II. METHOD

This type of research is descriptive research. This study uses two research methods, namely quantitative and descriptive qualitative research. They were collecting data in this study through observation in the form of test questions to determine learning outcomes. As well as pre-test and post-test value data to determine student learning outcomes.

This research includes Classroom Action Research (CAR) which is carried out to improve Electric Motor learning and increase student participation in learning. Classroom Action Research has four stages in one cycle, as shown in Figure 1. The stages are (i) Planning, (ii) Acting, (iii) Observing, and (iv) reflecting (Kemmis et al., 2014).

The implementation of this research was carried out in August-December 2019. This research was conducted at SMK N 2 Ternate City class XI TITL 2. The subjects of this study were students in class XI TITL 2 SMK N 2 Ternate City in the 2019/2020 academic year, totaling 31 students. The object of this research is the learning outcomes of students in class XI TITL 2 SMKN 2 Ternate City, the 2019/2020 school year through the application of a problem-based learning model.

Research material:

- Cycle I : Understand the types and characteristics of electric motors.
- Cycle II : Understand the various types of electric motor controllers.

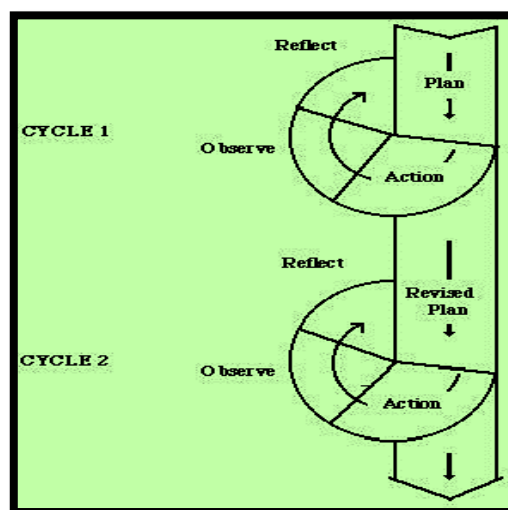


Figure 1. Schematic of the stages of implementing learning in CAR

The following are the stages of Classroom Action Research (Biott, 1983) that will be carried out in class XI TITL 2 SMK N 2 Ternate City for the 2020/2021 school year.

A. Cycle I

1. Planning

At the planning stage, the researcher prepares a lesson plan adapted to the problems students face in the classroom. The researcher also prepares everything needed to carry out the learning process, including the Learning Implementation Plan (RPP), Questionnaire (questionnaire), test instruments, and assessment instruments.

2. Actuating and Observing

At the stage of implementing the action, researchers carried out learning using the Problem-Based Learning model, which was expected to foster independence and increase students' willingness to take part in electric motor learning. In this study, the researchers divided into three activities: initial activities, core activities, and final activities.

3. Reflecting

Reflection is done to find out deficiencies during the learning process. By knowing the shortcomings during the learning process, the teacher is expected to be able to improve the following learning process to increase success in student learning. The learning process can be improved in the next cycle II.

B. Cycle II

The implementation of cycle II is almost the same as in cycle I. The implementation of cycle II is an improvement from the previous cycle. In cycle II, it is expected that errors or deficiencies that occurred in the previous cycle have been corrected or refined to run better, which will increase student learning success (Kunlasomboon et al., 2015).

III. RESULTS AND DISCUSSION

A. Cycle I

Researchers carried out the observation phase during the learning process. In this stage, the observations include two variables: motivation and learning outcomes.

1. Observation of Learning Motivation

This observation was carried out using instruments in observation sheets and questionnaires. The following are the criteria for determining the results of the student's Electric Motor learning motivation observation sheet (see Table 1).

Table 1. Criteria for Assessment of Students' Learning Motivation for Electric Motors

Category	Percentage
Very High	85.01 – 100.00
High	70.01 – 85.00
Medium	50.01 – 70.00
Low	.00 – 50.00

Based on the observations, the researcher was assisted by one observer using the observation sheet prepared previously, the data obtained in Table 2.

Table 2 is obtained from the total calculated value of the four statements that have been prepared previously. The maximum score in each statement is worth 4. In statement 1, regarding persistence in learning, a total score of 75 is obtained, then divided by the maximum number of scores obtained by 124 and multiplied by 100% to produce a percentage of 60.48%. For the second statement, the total score obtained is 78, with 62.90%. For the third statement, the total score obtained is 78, so the results obtained are 62.90%. In the fourth statement, the total score obtained is 75, resulting in 60.48%.

Table 2. Observation Results of Student Learning Motivation Cycle I

No	Learning Motivation Indicator	Score	Percentage
1	Perseverance in learning	75	60.48
2	Tenacious in the face of adversity	78	62.90
3	There is a drive and a need for learning	78	62.90
4	There is a desire to succeed	75	60.48
Total		306	246.76
Average Motivation Score		76.5	61.69

Based on Table 2, all indicators fall into the medium category (50.01% - 70.00%). Overall, the average score from the observation of students' learning motivation is 61.69%, so it is included in the moderate qualification.

Based on these data, the researcher assessed that the actions in cycle I had not been able to achieve the expected success criteria, namely, the average score was included in the high motivation qualification, so it was said to have not been successful and would be continued in cycle II.

2. Observation of Learning Outcomes

Learning outcomes in the cognitive domain of class XI TITL 2 students were measured by pre-test and post-test scores. The results of the pre-test will be compared with the post-test. It aims to determine the extent to which the improvement of student outcomes after implementing cooperative learning with Problem Based Learning techniques, the method of giving problems through videos and articles. Based on the pre-test and post-test assessments, the data obtained can be seen in Table 3.

There is an increase in the frequency/number of students whose score is 65 in the pre-test and post-test. During the pre-test, there were two students whose score was 65 or 6.5%, while in the post-test, there were 20 students who scored 65 or 64.5%. So that the increase is 58% or as many as 18 students, and vice versa, the value <65 has decreased by 58%. So it can be seen that cooperative learning with problem-based learning techniques can improve

students' learning outcomes in class X1 TITL 2. However, it cannot be said to be successful because the percentage has not reached the completeness criteria; 75% or as many as 23 students get a score of 65.

Table 3. Percentage of students' pre-test and post-test scores in Cycle I

Category	Pre-test		Post-Post	
	Frequency	%	Frequency	%
Grades < 65	29	93.5	11	35.5
Grades ≥ 65	2	6.5	20	64.5
Total	31	100	31	100

Data Table 2 shows the average motivation score from the observation sheet and questionnaire, respectively 61.69% and 71.875 %. The score on the questionnaire was included in the high category (57.6 < 76.8). For learning outcomes, the pre-test and post-test results showed an increase. However, this increase did not meet the expected completeness criteria; namely, 75% of students, or 23 students, had a minimum score of 65. Twenty-nine students had not reached the minimum completeness criteria in the pre-test, so only two students managed to exceed the completeness criteria. While in the post-test, students who had reached the minimum completeness criteria increased to 20 students. Meanwhile, students who have not reached the minimum completeness criteria are reduced to 11.

Based on these data, it can be said that the actions in the first cycle have not been successful. So that researchers, observers, and teachers reflect so that in the second cycle, the results will be better compared to the first cycle. Several things that are considered to have caused the unsuccessful actions taken in the first cycle are that students are not familiar with problem-based learning models. Students are not used to problem-solving analysis in learning, and the density of activities in learning also confuses students.

This is used as a lesson for improvement. So that the next cycle will be even better, in the second cycle, students will be briefed on what activities will be carried out during learning. Learning that aims to increase their motivation and learning outcomes needs to be implanted. There is also a need for motivation and encouragement from the teacher to arouse students' enthusiasm for learning. Encouragement also needs to be conveyed at all stages of activity, both when the teacher explains the material, when students work on activity sheets, organize thoroughly, and others. There needs to be an understanding that they are in a positive competition to get the highest score and get rewards for their group. The teacher will also motivate students to express opinions so that students want to ask if there

is something they do not understand. It is even better for students who still get the lowest or even lower scores on observations, questionnaires, and pre-test and post-test scores. The learning process is carried out by adding the duration of videos and exciting games and familiar and fun role figures. So it is hoped that learning will be more relaxed and much more fun but still refers to the goals to be achieved so that the motivation and results of students can increase.

B. Cycle II

1. Observation of Learning Motivation

Observations on learning motivation were carried out in two ways. One of them is by using observation. This observation was carried out by the researcher and assisted by one observer. The following are the criteria for determining the results of the learning motivation observation sheet (see Table 4).

Table 4. Criteria for Assessment of Students' Electric Motor Learning Motivation

Category	Percentage
Very High	85.01 – 100.00
High	70.01 – 85.00
Medium	50.01 – 70.00
Low	.00 – 50.00

Table 4 is obtained from the total value calculation of the four statements that have been prepared previously. The maximum score in each statement is worth 4. In statement 1, regarding persistence in learning, a total score of 89 is obtained, then divided by the maximum number of scores obtained by 124 and multiplied by 100% to produce a percentage of 71.78%. For the second statement, the total score obtained is 91, resulting in 73.38%. For the third statement, the total score obtained is 90, so the results obtained are 72.58%. In the fourth statement, the total score obtained is 91, resulting in 73.38%.

Table 5. Results of Observation of Learning Motivation in Cycle 2

No	Learning Motivation Indicator	Scores	Percentage
1	Perseverance in learning	89	71.78
2	Tenacious in the face of adversity	91	73.38
3	There is a drive and a need for learning	90	72.58
4	There is a desire to succeed	91	73.38
Total		361	291.12
Average Motivation Score		90.25	72.78

Based on Table 5, it can be seen that all indicators achieved high qualification (70.01% - 80.00%). The average score from the observations





reached the expected qualification, namely high qualification, which was 72.78%. So, it can be said that the learning can achieve the expected completeness criteria.

2. Observation of Learning Outcomes

The learning outcomes of class XI TITL 2 students after the second cycle were measured using pre-test and post-test questions. Based on the pre-test and post-test scores, the data is obtained in Table 6.

Table 6. Percentage of students' pre-test and post-test scores in Cycle 2

Category	Pre-test		Post-test	
	Freq.	%	Freq.	%
Grades < 65	21	67.74	7	22.86
Grades ≥ 65	10	32.26	24	77.14
Total	31	100	31	100

Table 6 shows that there is an increase between the pre-test and post-test. In the pre-test, the percentage of students who scored 65 was only 32.26%, or ten students, while in the post-test, it increased to 77.14%, or as many as 24 students. This shows that problem-based learning can improve learning outcomes and is included in the high category (Chan, 2012). So it can be said to be successful.

Some of the data in Table 5 shows that the average motivation score from the observation sheet is 72.78% and data from the questionnaire is 83.86%. The data shows an increase in scores from cycle I to cycle II, although some students are still included in the students who get the lowest score. In this second cycle, the score can exceed the expected completeness criteria, which is included in the high category (70.01% - 80.00%) both in observations and questionnaires—likewise, the score of students who get the lowest score. In cycle II, fewer students got the lowest score compared to cycle I. In the questionnaire, five students scored less than 70.01% - 80.00% in the questionnaire. However, learning can be said to increase learning motivation.

Meanwhile, there was also an increase from the previous cycle in the assessment of learning outcomes. In this second cycle, the value of students who are 65 has exceeded the standard criteria, which is 77.1% or 24 students in the post-test. This shows that the test results have increased from the previous cycle. This shows that the application of this learning can improve students' learning outcomes in class XI TITL 2. The implementation of learning in cycle II is better than in the previous cycle because improvements have been made to the deficiencies in cycle I.

Limited time implements activities in a hurry. Learning activities only last for 4 hours of lessons,

making it challenging to optimize problem-based learning model learning activities. Teachers are still not accustomed to using learning models (PBL). Teachers still often mix things up with lecture model learning (Revell & Wainwright, 2009).

The number of observers is still not proportional to the number of students being observed, so there is a little difficulty when observing. The number of observers consists of only two people, while the number of students is 31.

Students with high results still dominate the discussion time, so there is still a dependence on students who have low results. Students who have low learning outcomes prefer to remain silent and copy the work of students who have high enough learning outcomes (Feltovich et al., 2002).

IV. CONCLUSION

Based on Classroom Action Research (CAR), using problem-based learning (PBL) in Electric Motor subjects in class XI TITL 2 can improve student learning outcomes. Students can understand the material and have started to improve learning according to the observers' observations that have been carried out on students.

The approach through the problem-based learning method (PBL) of students in improving student learning increases. According to observer observations that have been carried out on students from cycle I to cycle II, and there is an increase in each cycle, the average cycle I is 61.69 increasing in cycle II to 72.78 with a total of 31 students in class XI TITL 2 SMK N 2 Ternate City.

Problem-based learning methods should be applied in every productive electrical power installation engineering subject. Teachers should apply problem-based learning methods to improve student's learning outcomes of electric motor installations. Conducting further research on this problem by involving many samples in the class taught using problem-based learning methods to see which results are better than the comparison between the two cycles.

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