

The Application of Problem-Based Learning Improves the Learning Outcomes of Electric Motor Installation for Students of SMKN 1 Kulisusu

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Abstract—This classroom action research aims to improve the learning process by applying a problem-based learning model to improve learning outcomes for the Electric Motor Installation Protection System class XI TITL students of State Vocational High School 1 Kulisusu. This study uses two stages of the cycle. Cycle I students achieved learning outcomes of 45.7% (incomplete) and 54.8% (completed), with an average score of 68.34. Cycle II students achieved learning outcomes of 11.42% (incomplete) and 88.57% (completed), with an average value of 82.51. Applying this learning improves student outcomes in the second cycle stage, namely the achievement results of 88.57% of the total 35 students, with an average value of 82.51. Thus, a problem-based learning model can improve student learning outcomes in class XI TITL State Vocational High School 1 Kulisusu.

Keywords: learning outcomes, problem-based learning models, Electric Motor Installation

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I. INTRODUCTION

Learning in Indonesia offers many kinds of learning models that teachers can use. So, the teacher must understand the concept of learning, which refers to achieving the learning goals. Teachers must be creative in developing their learning models, following the actual conditions in their workplaces (Tynjälä, 2008). Teachers can apply many learning models to overcome the problems above. One of the learning models is problem-based learning.

Many people are good at explaining the theory and concept of a problem but cannot provide solutions when facing real problems in life. Therefore, teachers as educators must be creative or able to create a new atmosphere in the learning process. One learning model that can develop students' skills is problem-based learning (PBL) (Anazifa & Djukri, 2017; Lembong & Tatali, 2023).

Thus, problem-based learning methods require students to learn about these problems until they can provide their conclusions about the situation that occurs, and finally, students can solve the problem (Hmelo-Silver, 2004). Problem-based learning is a contextual learning model that uses problems as the main focus of learning (Albanese &

Dast, 2013). The advantage of using problem-based learning in learning is that one of them can improve the analytical skills of students' learning in the electricity field, which needs particular attention because it is a supporting factor for students in the TITL class.

Learning outcomes are a picture of how students understand the teacher's material (Welerubun et al., 2022). Learning outcomes are output values in the form of numbers or letters that students get after receiving learning material through a test or exam delivered by the teacher (Eom et al., 2006). The teacher can learn how well students understand the material being studied from these learning outcomes. The success of students in achieving learning outcomes is different for each student. The factors influencing student success in achieving learning outcomes are grouped into internal and external factors (Lindblom-Ylänne et al., 2003). Internal factors come from within the student and include physical and psychological factors. Physical factors include health and disability factors. At the same time, psychological factors include intelligence, interest, motivation, and so on. At the same time, external factors are all outside students, including the family environment, community, association, learning facilities, family socio-economic conditions, and so on. Thus, the student's learning success results

from the interaction between the factors that influence it, both within (internal factors) and outside (external factors).

The teacher's teaching model that is not good will affect students' learning interest, which is not good either. This poor learning model can occur because the teacher is unprepared and lacks mastery of teaching materials. Hence, the teacher presents it unclearly, or the teacher's attitude towards the students is unsuitable. As a result, students are too lazy to learn. For this reason, using models in learning is crucial so that students do not get bored. Student learning outcomes can also increase. When attending a lesson or when the teaching and learning process is in progress (Bakkenes et al., 2010).

Meanwhile, the Directorate General of Higher Education provides an understanding that problem-based learning is a learning approach that uses real-world problems as a context for students to learn through critical thinking and problem-solving skills to acquire essential knowledge and concepts from the subject matter (Nafiah & Suyanto, 2014). From the description above, it can be concluded that problem-based learning is a learning model that focuses on tracking the roots of problems that exist in the real world as a learning context by involving students in the problem-solving process through the stages of the scientific method so that students learn to think critically and learn through experience—problem-solving—in order to acquire essential knowledge and concepts from the subject matter. PBL is a learning model that involves students solving a problem through the stages of the scientific method so that they can learn knowledge related to the problem and, at the same time, have the skills to solve problems (Ramdani et al., 2022).

Learning outcomes are changes in behavior in a person that can be observed and measured in the form of knowledge, attitudes, and skills (Mokalu et al., 2021; Phillips et al., 2018). This change can be interpreted as an increase and development that is better than before, and those who do not know become aware. Learning outcomes can be interpreted as the maximum results that a student has achieved after experiencing the teaching and learning process in studying a particular subject matter (Rombot et al., 2022; Schiefele, 1991). Learning outcomes are not absolute in the form of grades but can be changed in reasoning, discipline, skills, and so on, leading to positive changes. Understanding learning outcomes is a process to determine the value of student learning through assessment activities or measurement of learning outcomes (Keshavarz & Planning, 2011).

Problem-Based Learning (PBL) is learning that presents various authentic and meaningful problem situations to students (Ali, 2019; Mustafa et al.,

2022). In addition, in PBL, the teacher's role is to present authentic problems so that it is clear that students must be active in solving these problems.

Taking the learning model in subjects can cause learning difficulties (lack of activity). This is because the teacher does not master the material, more or less prepared, so the way to explain is unclear, and the students do not understand it. Factors from students include students becoming bored and students also tend to be shy or lack confidence in issuing ideas and ideas (Crum, 1993).

Less attractive teaching methods can cause students to become passive, so children are not active. Students do not listen to the explanation from the teacher. Students tend to look for other activities, and even students will sleep in class because they are bored. Factors causing low learning activity tend to be caused by the teacher. In learning, the teacher still uses conventional learning strategies (Crum, 1993).

The formulation of the problem in this study is: Can the application of a problem-based learning model improve learning outcomes for electric motor installation protection systems for class XI TITL students of SMK Negeri 1 Kulisusu? This study aims to find out whether applying a problem-based learning model can improve learning outcomes for electric motor installation protection systems for class XI TITL students of SMK Negeri 1 Kulisusu.

The results of this study are expected to be helpful as a reference for future research and also be able to contribute to the development of science, especially in the field of learning strategies and methods in electric motor installation subjects. Practical benefits: (a) For researchers, as a reference to increase knowledge and broaden insights and experience as a prospective educator who will go into the field. (b) For teachers, giving an overview of alternative learning models that are more effective in improving the quality of learning. (c) Using this learning model is expected to increase students' ability to understand the Electric Motor Installation Protection system.

A safety device is used to protect or secure or prevent an electrical installation system from a current load that exceeds its capacity. Current flowing in a conductor will cause heat in both the conductor and the electric device itself (Anderson et al., 2022).

One type of electrical safety has an element that can melt if the current that passes through it exceeds its rating. The workings of this type of safety are based on the heat generated due to the overcurrent flowing in the fused element protection (Toliat & Kliman, 2018).

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Non Automatic Fuse



Figure 1. Physical Fuse.

This type of security has a wire of the silver type with a mixture of other metals such as lead, zinc & copper. The working principle is to disconnect the melting wire if there is an increase in current in the system beyond its nominal limit (Anderson et al., 2022). Figure 1 is a physical image of a fuse.

Auto Fuse



Figure 2. Physical Auto Fuse

Physically, the shape is the same as a non-automatic fuse, but an automatic fuse has two buttons: a large button and a small button. The big button in the middle functions as a connection for electricity. When a short circuit occurs, the middle button will come out. The small button on the side functions to turn off the electricity (Anderson et al., 2022). Figure 2 is a physical image of the Auto Fuse.

MCB (Miniature Circuit Breaker)



Figure 3. Physical MCB.

MCB is a safety circuit with a thermic component (bimetal) for overload protection and an electromagnetic relay for short-circuit protection. MCB is widely used for single-phase and three-phase circuit protection (Anderson et al., 2022). Figure 3 is a physical image of the MCB.

In the working principle of a protection system, it is also known as overlapping. Namely, in one

protection area, protection components are installed simultaneously or overlap. The existence of this overlapping is helpful to support the working of the protection system in securing and neutralizing disturbances that occur if one of the protection components does not work. Other protection components can back up to secure these electrical machines (Lagu & Wardana, 2023; Toliyat & Kliman, 2018).

Based on these thoughts, the authors draw the research hypothesis as follows: applying a problem-based learning model can improve learning outcomes of the Electric Motor Installation Protection System for class XI TITL students of SMK Negeri 1 Kulisusu. So, this research aims to improve the learning outcomes of the Electrical Motor Installation Protection System for class XI TITL students of SMK Negeri 1 Kulisusu by applying a problem-based learning model.

II. METHOD

The method used in this study is a type of classroom action research to obtain information. This research was carried out for approximately two months, from May to June 2022, in class XI TITL at SMK Negeri 1 Kulisusu. The subjects of this study were students of class XI TITL at SMK Negeri 1 Kulisusu, which consisted of 35 students.

This study uses the action research model from Kemmis and Taggart in a spiral from one cycle to the next (see Figure 4).

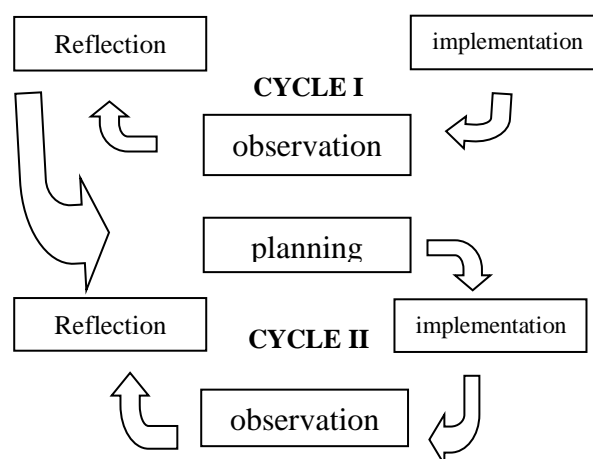


Figure 4. CAR Procedure, Lewis Kart Model

The procedure of this research is as follows:

- (1) The planning stage of the steps used in this planning is (a) Studying material and learning indicators for basic electric motor installation, (b) Compiling RPP according to indicators through learning models, (c) Preparing resources

according to subject matter that supports the learning process, (d) Prepare evaluation tools in the form of evaluation sheets and student worksheets, (e) Prepare observation sheets to observe teacher and student activities in the learning process.

- (2) Implementation. At this stage, the activities carried out are implementing the learning activities contained in the lesson plan by providing material so that the material will be provided.
- (3) Observation. Observation activities occur when the action in the form of learning activities begins. Teacher and student activities in learning are observed by observation, in this case, the teacher.
- (4) Reflection. Reflection activities are carried out after the learning activities have been completed and, based on the learning outcomes and observer record data obtained, jointly discussed to find strengths and weaknesses. As for the weaknesses, solutions are sought for improvement at the next cycle stage.

Working Indicators, this classroom action research is said to be successful if students who score above the completeness criteria drink 80% of the total number of students and students achieve an average score of 75 based on the results of the electric motor installation subject.

The data collection techniques used in this study are:

- (1) Written Test. A written test is a systematic procedure made through standardized written assignments and given to individuals or groups to work on, answer, or respond.
- (2) Documentation. Documentation is a tool for collecting data by collecting and analyzing documents, both written documents, pictures, and electronics.
- (3) Observation. Students' activities are observed at the observation stage, and assessment tests are carried out during learning and at the end of learning.
- (4) Worksheets are a source for students to acquire knowledge and learning materials.
- (5) Learning Outcomes Test, the learning outcome test is used to measure students' mastery of the material that has been taught and can measure the development of students' learning progress.

The data analysis technique used to analyze the success rate of the data is to compare learning outcomes through evaluation in the form of

assignments. To calculate the percentage of learning outcomes, we used Formula 1.

$$P = \frac{\sum n \times 100N}{N} \quad (1)$$

For:

$\sum n$ = The number of frequencies appears

N = Total number of students

P = Frequency percentage

III. RESULTS AND DISCUSSIONS

The pre-cycle results obtained by researchers before applying the learning model obtained data regarding the learning conditions at SMK Negeri 1 Kulisusu, especially class XI TITL. The learning system is still one-way, where the teacher plays an active role in the learning process, while students only listen to what is conveyed, so students tend to be passive in the learning process. The following are the learning outcomes obtained from the pre-cycle stage.

It can be seen that the recapitulation table for student achievement results through the pre-cycle test is shown in Table 1.

Table 1. Recapitulation of Pre-cycle Learning Outcomes

No	Test Results	Achievement
1	The Highest Score	75
2	Lowest Score	30
3	Average Score	56.43
4	Number of Completed Students	11
5	Number of Unfinished Students	24
6	Study Completeness Percentage	31.42

Based on the pre-cycle in Table 4, it shows that 11 students achieved learning completeness, or 27.58%, and 24 students, or 31.42%, had not achieved learning completeness. The average value obtained is 56.43. This shows that the results students achieve are still not following the targets to be achieved.

Based on the values from the pre-cycle acquisition, it can be seen that by using only one-way methods without any other methods that support student brain development, it does not increase. The results of this Classroom Action research can be described in two stages of the research cycle carried out in class. This Classroom Action Research was carried out in two cycles consisting of six meetings.

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Cycle I

Planning stage

- 1) Make lesson plans so that the teaching and learning process implementation goes as expected, as well as a teacher's guide in carrying out learning.
- 2) Preparation of teaching materials, including preparing the material to be delivered.
- 3) Prepare the media to be used in the teaching process.
- 4) Develop an assessment format.
- 5) Compile teacher observation sheets about the implementation of learning to find out student learning outcomes.

Implementation Stage

This stage is the implementation in class, namely the implementation of theory and what has been prepared beforehand and can be expected to be effective using a problem-based learning model. The implementation of the actions in cycle one is carried out according to the learning scenario that has been prepared, namely by conveying the learning objectives and preparing students so that in the teaching and learning process, they can adjust to the learning model applied, aimed at delivering material.

Implementation of cycle 1 carried out learning with competency standards to understand pictures of the electric motor installation and imitate electric motor installation.

Initial activity:

- a. The teacher prepares the class for the teaching and learning process and greets and checks student attendance.
- b. The teacher prepares the learning media that has been provided.
- c. The teacher explains the competencies that must be achieved in learning activities.
- d. The teacher provides learning motivation to all students to participate in teaching and learning activities in an orderly manner.

Core activities:

- a. The teacher gives material about presenting material impressions of types of electric motor installations.
- b. Identifying problems students in groups discussing the definition of electrical safety in electric motor installation.
- c. Students explore information about the types of electric motor installations.
- d. After seeing the results of student work, the teacher evaluates the results of student work.

- e. The teacher again explains how electric safety works and the symbol for installing an electric motor.

End activities:

Evaluate, reflect, and respond as well as the teacher provides conclusions and feedback on the activities that have been carried out.

Observation Stage

Observations made during the implementation of learning using the problem-based learning model in cycle I can be seen by students listening to the material presented and recording essential things from the material being taught to practice. However, there are still students who are lazy in learning, students who only play on cellphones and still do not answer questions from the teacher, and students who are still not active enough to ask questions to the teacher. These things will impact student results through the tests carried out. Implementation of the research cycle I have not gone well. Of course, students must be conditioned according to the learning plan by using the problem-based learning model. Table 2 is the student learning outcomes in the first cycle test.

Table 2. Recapitulation of Test Results I

No	Test Results I	Achievement
1	The Highest Score	87
2	Lowest Score	33
3	Average Score	68.34
4	Number of Completed Students	19
5	Number of Unfinished Students	16
6	Study Completeness Percentage	54.28

The recapitulation of student learning outcomes in cycle I can be seen in Table 2. Table 2 shows that student scores in cycle I increased the average value to 68.35%, and the mastery presentation was 54.28%. Even though it has resulted in changes in completeness, the desired standard of completeness has not been achieved.

Following the success of the first action cycle, various hurdles in executing the action were discovered because sure students did not wholly comprehend the mechanics of the activities created. In the next action cycle, the teacher needs to add and correct the deficiencies found so that the learning objectives and learning objectives using this model can be seen.

The results of reflection are used as a guide so that the constraints and deficiencies that occur will be minimized; because students are still adapting to the problem-based learning model, the efforts made by





the teacher to improve student learning outcomes in cycle I have not obtained maximum results, this is evidenced by way of learning students who are still not active in the learning process. Improvements in cycle II are required based on the findings of the cycle I observations.

Cycle II

Planning Stage

- 1) Develop a learning implementation plan with a problem-based learning model.
- 2) Arrange a written test.
- 3) Develop an assessment format.
- 4) Compile teacher observation sheets about the implementation of learning.

Implementation Stage

Based on the results obtained in cycle I, students have not obtained scores above the average completeness. With that, the teacher adds a few changes to obtain maximum results.

1. Initial Activities

- a. The teacher prepares the class for the teaching and learning process, greets, checks student attendance, and disciplines the class.
- b. The teacher prepares learning media.
- c. Motivate students to be more severe and active in the teaching and learning process and provide additional encouragement to students considered prosperous and still less successful.

2. Core Activities

- a. The teacher conveys the learning objectives to motivate students to generate student initial knowledge related to electric motor installation.
- b. The teacher explains the material to be discussed by students where the material is a repeated material and a continuation of the cycle I.
- c. Using a learning model, a problem-based learning model, an improvement from Cycle I.

Observation Stage

The teacher carries out this activity as a researcher. At this stage, the teacher recognizes and documents the entire process and the results of the changes in the learning process. Several things are observed, namely the accuracy of the strategies compiled and the students' activeness.

In this second cycle, students began to look active in learning even though some were still not active in learning and did not give applause to friends who did their assignments well. Students can overcome difficulties by staying active to provide guidance. In addition to providing guidance, the teacher also motivates to learn to students. The results

of observations show that student learning outcomes in cycle II are better than in cycle I; this is indicated by an increase in student activity in carrying out the learning process using the Problem-Based Learning model. Students are getting used to the problem-based learning model. Students become more prepared, active, and directly involved when learning occurs. Implementing research in cycle II, teaching and learning activities using problem-based learning models went better than in cycle I.

Reflection

In cycle II, students were more active than in cycle I. Almost all students actively participated in learning, and there were not many who often asked questions but were able to explain the material provided well. Student participation in teaching and learning activities increases; students can work together to grasp the teacher's lessons by explaining them to friends. The recapitulation of student learning outcomes in cycle II can be seen in Table 3.

Table 3. Recapitulation of Test Results I II

No	Test Results II	Achievement
1	The Highest Score	95
2	Lowest Score	40
3	Average Score	82.51
4	Number of Completed Students	31
5	Number of Unfinished Students	4
6	Study Completeness Percentage	88.57

Table 3 shows that the average value of students in cycle II is 82.51 and has achieved an average value of 75 with a learning completeness percentage of 88.57%. The application of researchers during the learning process dramatically determines the success of student learning.

In the results of the cycle I test, the results of the first cycle test had not reached the completeness targeted by the researcher, and the shortcomings included the researcher not having conditioned the class optimally; it was proven that there were still many students who were less attentive and less active in the teaching and learning process, lacked learning initiative, still lacked confidence in expressing opinions.

The problems encountered are corrected by better supervising all students in the learning process and providing more guidance to students who experience difficulties or do not experience learning difficulties. From the learning results of cycle II, deficiencies and difficulties have been successfully faced with a good plan. An increase in student learning outcomes can be seen from the achievement targets that have been met because the percentage of student completeness has reached 88.57%. With a

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score of 75 for the achievement, the student has achieved the required learning mastery.

In cycle I, it turned out that the number of students who passed increased by 54.28% or 19 students with an average score of 68.35%. This result has not reached the target set by the researcher, namely the number of students who experience completeness. From the practical work done by the teacher, it is known that the initial conditions were 24 students who did not reach the completeness standard and only 31.42% or 11 students who achieved the completeness standard with an average score of 56.43.

The learning process with a problem-based learning model makes students more creative and more aware of the essence of learning. With a group, the advantages of applying a problem-based learning model can improve problem-solving skills and collaboration and increase students' talents and creativity in processing resources. This statement follows what is done.

This research is supported by previous research that the problem-based learning model used from cycle I to cycle II can improve student learning outcomes (Paramarta et al., 2019). After the evaluation results, the less optimal student learning outcomes in the first cycle were caused by the fact that researchers were not used to understanding class conditions correctly. It was seen that there were still many students who were not active in the learning process.

In the implementation of cycle II, it can be seen in the results of the research that students have started to be motivated and have started to be active in the teaching and learning process in the classroom so that the teacher can build students' thinking so that they can develop their thinking.

With the use of the project-based learning model applied, it can be seen from the existing 35 students, 31 students, or 88.57%, achieved the completeness standard, and only four students, or 11.42%, did not reach the completeness standard with an average score. Learning outcomes 82.51. Thus in cycle II, it has met the criteria of learning completeness, so this classroom action research is said to be successful.

IV. CONCLUSION

Based on the results of this classroom action research, it can be concluded that the learning process using problem-based learning models can improve student learning outcomes. With mastery learning in cycle I, student learning outcomes increase with an average score of 68.34 with the highest score, then in

cycle II, obtain maximum results with an average score of 82.51 with the highest score of 95.

And then, in cycle I, the percentage of completeness increased to 54.28% with the number of students who completed, namely 19 people, and those who did not complete, namely 16 students. Furthermore, in cycle II, the presentation of student completeness increased significantly with a percentage of 88.57%, with a total of 31 students who completed and four students who did not complete. Applying a problem-based learning model to improve learning outcomes of electric motor installation for class XI TITL students of SMK Negeri 1 Kulisusu can be concluded that overall, there has been an increase in learning outcomes.

Based on the conclusions from this classroom action research, it is suggested to teachers and students as prospective teachers to choose a reasonable and appropriate learning model and always pays attention to the development of student learning outcomes; student discipline in the problem-based learning process can be used in the teaching and learning process and can improve results learn from before.

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