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[Research Article]

THE LEARNING DESIGN TO IMPROVE THE LEARNING OUTCOMES ON THE ELECTRICAL CIRCUIT TOPIC

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ABSTRACT

This study aims to determine the implementation of the project-based learning process on electrical energy topic in class VI and the improvement of student learning outcomes in science learning on electrical energy topic. This research was conducted on students of class VI with a total of 29 students consisting of 13 males and 16 females. There were three times of data collection in this study which included Pre-Cycle, Cycle 1, and Cycle 2. The results showed that the active involvement of students in learning activities could increase their understanding of the subject matter being taught. In addition, project-based learning by making series and parallel circuits in the implementation of making traffic lights makes students more enthusiastic and active in learning.

Keywords: Classroom action research, Project based learning, Traffic light

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1. INTRODUCTION

The problem of energy should be solved jointly. At the elementary school level, efforts that can be done by the teacher are to provide an understanding of the importance of saving energy for life sustainability. It's delivered through the learning activities designed in such a way as it can raise awareness in students (Wulandhari et al., 2019). However, with the learning process, the students' awareness related to energy saving in everyday life has not appeared.

Along with the implementation of the 2013 curriculum that emphasizes the scientific approach, students are expected to explore the potential and to get knowledge through the guidance given by the teachers. The role of the teachers as a facilitator requires them to actively design the learning that can help students understand the learning process. In addition, the learning of which is arranged in the form of thematic also be attention to the teacher so numerous fields of science can be integrated into a learning process (Sundari, 2017). However, on learning in the classroom, students tend not to show interest related to the energy utilization topic.

Based on the experience of the researcher, one of the topics difficult to be understood by students is Electrical Energy which is part of the topic of natural science subject (IPA). On the formative test, the average grade obtained was only 70,52 which is lower than the Minimum Completeness Criteria (KKM) of 73,00. Explicitly, there are 16 (55.17%) students who are below the KKM. So, there should be an effort to improve the learning outcomes of students to fulfill the minimum standard.

The low ability of students in understanding the concept of energy is an indication that the students' literacy is low where electrical energy is very close to the students' life. Nationally, this fact also confirms the findings of PISA which states that students in Indonesia tend to still have the ability of science literacy is low (Nugrahanto & Zuchdi, 2019).

This fact indicates that learning science, especially the topic of electrical energy needs to be fixed so that the learning outcomes of students can be improved. Teachers should look for learning innovation, so the management of the learning process can make it easier to understand the learning topic so that the learning outcomes of students can achieve the criteria expected.

The topic of electrical energy can be learned through the creation of a simple project (Hosseinzadeh et al., 2009; Hosseinzadeh & Hesamzadeh, 2012; Iturregi et al., 2017). The simple project aims to demonstrate the consumption of energy and awareness to save energy, especially electrical energy. In addition, the creation of the project can also improve the creativity of students and make learning more fun.

Learning projects can be conducted by using the learning cycle (Baptist et al., 2020; Zhong & Dockweiler, 2020). The Learning cycle is a learning model that is centered on the students, it is a series of stages of activities are arranged in such a way that students can master the competencies that must be achieved by being actively involved in learning. The cycle of learning is developed based on the theory developed in the present about how students should learn. This method is easy to be used by teachers and can provide the opportunity to develop the students' creativity and learning.

Stages in the learning cycle include engagement, exploration, explanation, expansion, and evaluation (Rodriguez et al., 2019; Wilder & Shuttleworth, 2005). At the stage of involvement, students learn through engagement and actions, their ideas, and the relations with the new topic that is introduced with the guidance of the teachers to allow students to apply previous knowledge, develop their interests, cultivate and nurture curiosity towards such topic. The learning material needs to be arranged carefully so that the targeted learning uses the fundamental concepts and ideas. During this stage, the teacher assesses the understanding of the students to the target lesson. This stage is usually conducted at the beginning of the learning in the form of

questions and answers. The teacher tests students' understanding of the topic previously learned.

In the exploration phase, students have to be given the opportunity to work together with their friends without guidance from a teacher. This phase is an opportunity for students to test hypotheses or predictions of them, discuss with their groupmate and set decisions, interact with the environment through activities such as lab work, analyze the article, discuss the phenomena of nature, observe natural phenomena or social behavior, etc. From this activity, expected to arise imbalance in the structure of his mental state that is characterized by the emergence of questions that lead to the development of a mindset that begins with the words like 'why' and 'how'. These questions are an indicator of the readiness of students for the next stage.

At this stage, students use the data they have collected to solve the problem and to report what they are doing and try to Figure out the answers to the problems. The teacher also introduces the new vocabulary, phrases, or sentences to label what the students already know.

At the stage of expansion, the students develop the concepts that just learned to be applied in other examples, used as an illustration of the concept that can help students develop the ideas in their life through activities such as solving the problems of the real or experimenting.

The evaluation stage wants to know the explanation of the students to the learning cycle. Evaluation can take place at any stage of learning, to direct the understanding of the concept and the development of skills. The teacher's task is to observe the knowledge and skills of students in applying the concepts and to observe the changes in the students' thinking. Usually, this phase is conducted at the end of the learning session in the form of question and answer to find out how far the students' understanding of the topics that have been learned or in the form of the test as the evaluation of the students' ability.

Based on the elaboration of the research background, in this study, the researcher focuses on improving the learning outcomes of students of class VI in Tangerang City, through project-based learning. The topic is the utilization of electrical energy in everyday life with the student's project is the series and parallel circuit. The research questions in this study are as follows:
RQ 1: How was the implementation of project-based learning in the topic of the electrical circuit?
RQ 2: How was the increase of student learning outcomes after project-based learning on the topic of the electrical circuit?

2. METHODS

This research was conducted in class VI in a public elementary school in Tangerang City. This research was conducted on 29 students which consist of 13 men and 16 women.

The research procedure consists of 4 stages: planning, action, implementation of the action, observation, and reflection. Reflection is conducted in the pre-cycle and will be repeated in the next cycle. Before the study, early observation is conducted on the results of students learning, then proceed to the research of cycle 1 which begins with the planning phase, then the implementation of the action class as in Figure 1.

2.1 Pre-cycle

The first step in the pre-cycle step is to prepare a lesson plan according to the semester program and learning syllabus. The stage of the pre-cycle is to implement learning activities following the lesson plans that have been made. Learning activities consist of the initial activities, core activities, and the activities of the end.

The next step of pre-cycle is observation. In this step, the authors observe whether there are things that need to be fixed immediately. Through the evaluation, it will be found weaknesses that exist on the actions that have been carried out to then be used as the basis for refining the action plan on the next cycle.

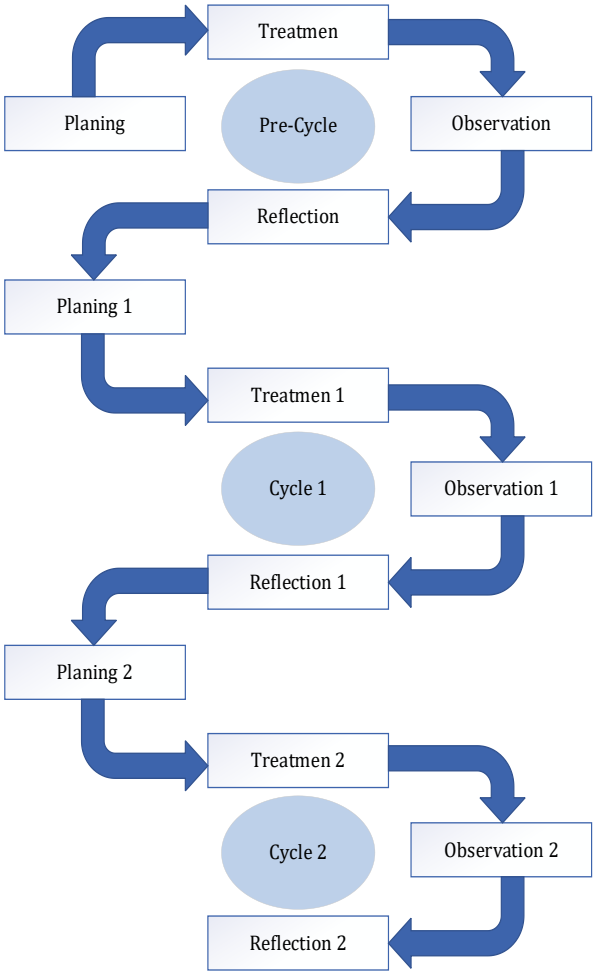

Figure 1. Research Procedures

The last activity of pre-cycle is a reflection. This step is to observe, assess, and analyze in-depth the steps that have been implemented in the evaluation step. At this stage, the results of the evaluation were collected by the author and communicated as well as analyzed with colleague. The results of the analysis will be used as a reference to plan further action. Based on the analysis, the new activities plan is created to be implemented at the stage of cycle 1.

2.2 Cycle 1

Based on the problems in this study, the authors formulate a plan of action that will be implemented as an effort to solve the problem in research. The action plan is structured to test the hypothesis, whether the plan of action undertaken is relevant and in sync with the root of the problem. The topic that will be discussed in the first cycle is about the use of electrical energy in everyday life with the planning of the research include 1) Preparing the syllabus and lesson plan; 2) setting up the scenario of learning; 3) Preparing learning materials; 4) Preparing learning media; 5) Prepare questions; 6) Preparing the answer sheets; and 7) Preparing a sheet of students assessment.

The second phase of cycle 1 is the implementation as an effort to improve learning outcomes of students through learning remedial. Learning activities consist of the initial activities, core activities and end of the activities include: 1) the Teacher explains the learning objectives or competencies to be achieved; 2) Convey the main points of learning topics; 3) Teacher allows the students to read the material in the form of text explanation; 4) Teacher divides the students into several groups; 5) Teacher asks the students to draw up and observe the difference between a series circuit and parallel circuit; 6) After observations, participants are allowed to discuss the results of his observations; 7) to increase the understanding, the teacher asks the students to make a simple traffic lights project; 8) Teacher gave suggestions and conclusion of the work of each group.

The third stage is the stage of observation or execution of the test. In this step, the researcher can determine whether there are things that need to be fixed immediately so that the action can achieve the desired goal. Through the evaluation, researchers will find the weaknesses that still exist in the actions that have been carried out to be used as the basis of refining the action plan on the next cycle.

The last stage is reflection. The activities in this step are to observe, assess, and analyze in-depth the implemented actions based on the data that has been collected on the evaluation step. At this stage, the results are obtained from the evaluation of the collected and analyzed jointly by researchers, so it can be found whether the activities are following the planned objectives. The results of the analysis will be used as a reference to plan further action until the existing problems can be resolved.

2.3 Cycle 2

In the second cycle, such actions are carried out similarly with cycle I. the subject topic is about the use of electrical energy in everyday life. The whole learning material are following the actions performed. Learning activities consist of the initial activities, core activities, and end of the activities as outlined below: 1) Teacher explains the learning objectives or competencies to be achieved; 2) Teacher gives 3 questions in the opening to repeat the topics at the previous meeting; 3) the Teacher convey the essential points in the learning topic; 4) Teacher divides the students into several groups; 5) Teacher asks the students to draw up and observe the difference between a series circuit and parallel circuit; 6) After making observations, participants are given the opportunity to discuss the results of his observations; 7) to increase the understanding, the teacher then asks the students to make a simple traffic lights project; 8) Teacher gave suggestions and conclusion of the work of each group.

The second stage of this research is the implementation of efforts to improve learning outcomes of students through remedial of learning. The third stage is the stage of observation or execution of the test. In this case, the researcher can determine whether there are things that need to be fixed immediately to achieve the desired goal. Through the evaluation will be found the weaknesses that still exist on the actions that have been carried out to be used as the basis of refining the action plan on the next cycle.

The last step is reflection. The activities in this step are to observe, assess, and analyze in-depth the activities that have been implemented based on the data that has been collected in step evaluation cycle 1 and cycle 2. At this stage, the results obtained from the evaluation are collected and analyzed jointly by researchers, so it can be known whether the activities carried out are in accordance with the planned objectives. The results of the analysis will be used as a reference for the research results.

The type of data in this research is qualitative data from observation results. In simple terms, observation means observation with a specific purpose to collect data from the repaired results. Observation of classroom action research conducted on the teacher as a researcher by colleagues, and observation of the students as the research subjects. The student observation sheet as the subject of the improvement of the research is the observation of the activity of the students during the learning process.

To find out the results of the improvement of learning, the data was collected through the test. Tests are included in the lesson plan of each cycle. The results of the test of learning are inserted into a Table and then described so that the known improvement of learning each cycle.

Data collection techniques are carried out by observation to the subject of study, students complete the test questions every end of the cycle and carry out observations when the learning process takes place. The results of each observation are analyzed to create action in the next cycle.

The Data collected were then analyzed quantitatively and qualitatively. Furthermore, the data results of the observations are interpreted with reference to Table 1.

Table 1. The Observation Format of Success Indicators

No	Observed Aspect	%
1.	Students' activeness to solve the questions	65
2.	The creativity of students in making the traffic lights project	70
3.	Timeliness in answering questions with the owned media	75
4.	True and exact answers	75

3. RESULTS AND DISCUSSION

3.1 Pre-Cycle

The measurement results show that on learning of the pre-cycle, the learning outcomes of students tend to be very low. Learning is passive and activity of the students did not reflect the

activity-oriented learning on the scientific approach (5M). Based on the minimum completeness criteria set forth, of the 29 students, only 12 students meet the minimum criteria for completeness. In fact, 73 as the minimum completeness criteria is relatively low compared to other subjects.

Learning activities at the pre-cycle stage by using the learning media "number line" on the topic of energy power refers to unsatisfactory results. Most of the students are not involved actively in the learning activities. Most of the students are not so show interest and motivation in science learning in particular on the topic of electrical energy. On learning of the pre-cycle, the low achievement of the students allegedly comes from several factors. Among them is the lack of learning activities carried out so that there are students who focus listen to the explanation and there are still many who can't focus to listen to the explanation from the teacher. In addition, the activities of the teachers just explain verbally the material energy saving becomes one of the factors that lead to students having difficulty in understanding the topic because in science subject several topics and terms tend to be easier in practice or observed by the students.

This problem becomes a reference for researchers to repair learning until the subject matter is completely understandable for the students. Explicitly, the results of the study at the stage of pre-cycle used as a reference for the improvement is the evaluation results shown in Figure 2.

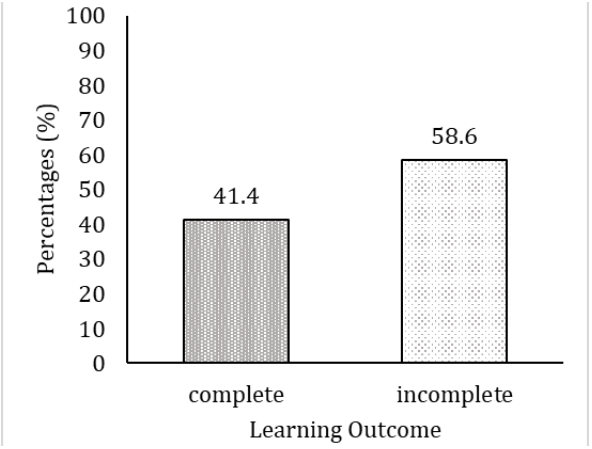

Figure 2. Completeness of Learning Outcomes of Pre-Cycle Stage

Because the percentage of completeness of learning at the stage of pre-cycle is very low, the author tries to reflect and communicate with colleague. The results of the reflection of the authors after carrying out the learning activities at the stage of pre-cycle is shown in Table 2. The focus of reflection is the explanation of the concept, the utilization of science instruments, methods of teaching, mastery of the class, and the students' activity.

Table 2. Self Reflection of Pre-Cycle

No	Aspect	Appearance		Self-reflection
		Available	Not Available	
1	Explanation of the concept by the teacher	✓		Teacher is too fast to explain the concept
2	the Use of science instrument	✓		science instrument only is used by students who are active only in the group, while the other is still passive
3	Use methods of teaching:	✓		Methods need improvement.
4	classroom management	✓		Some students keep asking permission to go outside of class
5	Activity students	✓		Some students are active and others passive in activities

After evaluation at the end of learning, it is seen that from 29 students of class VI A, only 12 students, or 41.4 % reached the KKM score. The average score of the evaluation of students at the stage of pre-cycle is 70.52 (under KKM). This shows that the learning activities at the stage of pre-cycle are not successful. Therefore,

there should be improvement activities learning in cycle 1.

3.2 Cycle 1

In carrying out the learning process in cycle 1, the author was observed colleague who sit in the back of the class. The results of the observations of colleague can be seen in Table 3 with the focus of the observation are explanation of the concept, the utilization of science instruments, teaching methods, students' tasks, mastery of class management, and the activity of students.

Table 3 Implementation of Cycle 1

No	Observed Aspect	Appearance		Comments
		Available	Not Available	
1	Explanation of the concept by teacher	✓		Good enough
2	Use of science instruments	✓		Most of the students actively create and observe electrical circuit.
3	The use of teaching method:	✓		Good enough
4	Class assignment	✓		Some students pay less attention to the lesson
5	Classroom management	✓		Some students keep asking permission to the outside of the grade
6	Activity of students	✓		Some students are active and others passive in activities

In cycle 1, the increase of learning success in science learning about "electrical energy" is small. In general, students are already engaged in the learning activities in cycle 1. Students can also distinguish between the circuit series and parallel in the electrical circuit. However, after the test questions, there are still students who are confused to connect the results of observations and the completion of test questions, described in Figure 3.

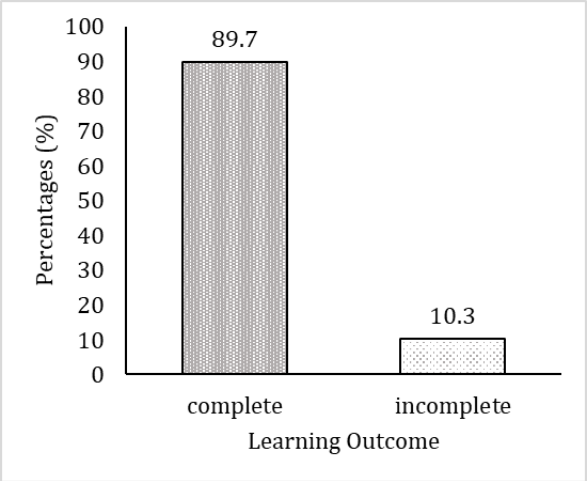

Figure 3. Completeness of Learning in Stage of Cycle 1

Based on Figure 3, 24 students or 89.7% of class VI A get the score above the school KKM. While only 3 students or 10.3% get the score below the school KKM. These data indicate an increase in the number of students who reached the KKM score which is 48.3% in the pre-cycle stage.

Figure 3 also shows the percentage of success of the students who reached the KKM score in cycle 1. It can be said that there are students who less master the learning materials so that learning can not be said to be entirely successful. Therefore, it's necessary to repair by carrying out the re-learning in cycle 2.

3.3 Cycle 1

In carrying out the learning process in cycle 2, the author is still observed by a colleague who sits in the back of the class. The results of the observations of a colleague on the stage of cycle 2 can be seen in Table 4 with the focus of the observation are explanation of the concept, the use of science instruments, teaching method, students' task, mastery of the class management and activity of the students.

Table 4 Implementation of Cycle 2

No	Observed Aspect	Appearence		Comments
		Available	Not Available	
1	Explanation of the concept by teacher	✓		Good
2	Use of props	✓		All students enthusiastically creating and observing the electrical circuit.
3	The use of teaching methods.	✓		Good
4	Class assignment	✓		Good
5	Mastery of class management	✓		Quite good
6	Students' activity	✓		All students were actively involved in the learning activities

Based on the results of observations by colleague, the learning activities in cycle 2 is following the plans made. After completion of the learning activities, a written evaluation is conducted. The value of the evaluation of students in cycle 2 can be seen in Figure 4.

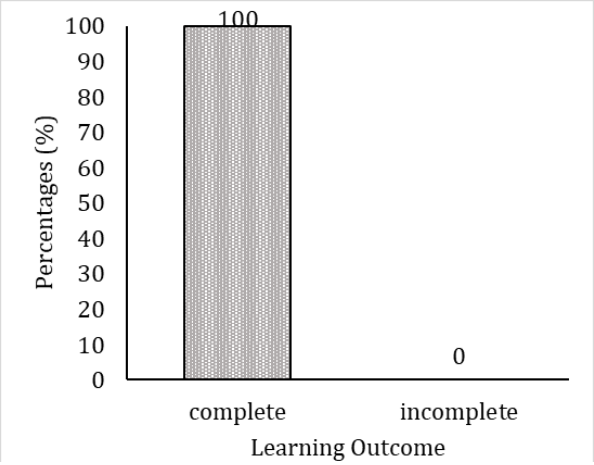

Figure 4. Completeness of Learning in Cycle 2

Based on the Table in Figure 4, 29 students or 100% of class VIA reach score above the school KKM, and students who score below the school KKM is 0 person or 0 %. These data indicate that after doing a cycle of learning as much as 2 times, students pass the science subject fully.

Based on the results of observations of colleagues, during the learning activity cycle 2 and the results of the evaluation obtained by the students at the end of the learning, it can be said that learning in cycle 2 is in accordance with the plans made. Obstacles are not found during the implementation. From the above data, it can also be seen that of the 29 students of class VIA passed the KKM score. However, there is a decrease in the average grade compared to the cycle to 2. It can be said that the majority of students have already mastered the learning materials so learning can be said to be entirely successful.

The success is certainly not separated from the explanation of the concept by the teacher who gets better, the use of learning media that can enable all students (Puspitarini & Hanif, 2019; Simamora, 2020), the use of methods of teaching, as well as the class management that is good enough (Bai et al., 2020; Castro, 2019; Khalaf & Mohammed Zin, 2018). Students can solve the test evaluation well with an average of 85.86 (above the KKM). It shows that the learning activities in cycle 2 show success and a conclusion can be drawn from this research.

The percentage of success of the students who reached the KKM value on each cycle shows an increase. More details can be seen in Figure 5.

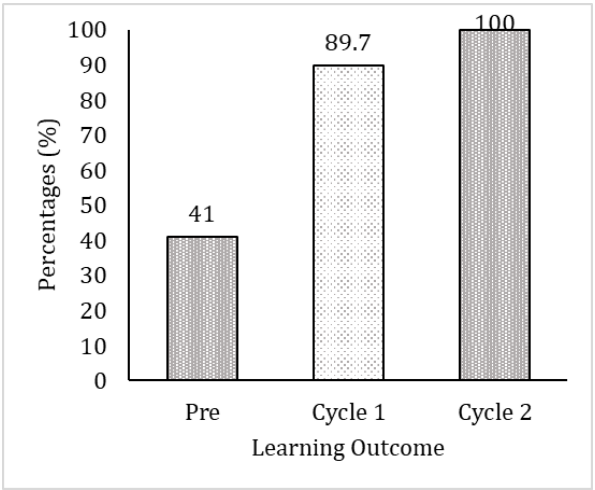

Figure 5. The percentage of Mastery of Learning by students

The chart above shows the increase in learning outcomes of students in cycle 2 at 87.5 %. Based on the success indicators of learning which is 75% of the right and proper answers, the authors conclude that research in an effort to improve learning outcomes of students towards learning science about electrical circuits with the design of project-based learning-making the traffic lights on the students have been successful (Asrizal et al., 2022; Imran et al., 2019; Özenc et al., 2020; Rahmawati et al., 2021).

4. CONCLUSION

From the results of observation during the pre-cycle, cycle 1, and cycle 2 the authors found several things: 1) the Involvement of the students actively in the learning activities can improve their understanding of the subject being taught; 2) project-based learning to create series and parallel circuits and traffic lights make the students be more enthusiastic and active in learning.

Based on the analysis of data and discussion as seen on the 4 with theme of globalization (special topic of electric energy), the results of this study can be concluded that project-based learning in the topic of electrical energy can improve the learning achievement of students, especially the students. This we can be proven by the presence of a) the average value of the evaluation of the formative assessment (etst) increased from 70.52 at the stage of pre-cycle to 86.64 on the stage of the cycle 1 and rose again to 85.86 on the stage of cycle 2; b) There is an increase of percentage of students who have reached the KKM score from 41.4% at the stage of the pre-cycle ride to be of 89.7% on the stage of the cycle 1 and go up again to 100.0% on the stage of cycle 2; c) The percentage of increase of students who have reached the KKM from pre-cycle to cycle stage 1 is equal to 48.3%, while from cycle 1 to cycle 2 was 10.3%.

Learning will be more interesting and meaningful when students are directly involved in the learning activities. Project-based learning where students make the traffic lights make students becosme more active in learning. Thus, it has been proved that with the design of project-based learning with the project of automatic traffic lights can improve the learning outcomes of students on the topic of electrical energy.

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