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Improving Activities and Learning Outcomes of Elementary School Students Through Experimental Methods Using Lime as an Alternative Electrical Energy Source during the Covid-19 Pandemic

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ABSTRACTS

Elementary schools have been carrying out online learning for approximately 2 years in an effort to break the chain of transmission of Covid-19. We conducted research with the aim of seeing the extent to which the experimental method applied in learning could improve the activity and learning outcomes of sixth grade elementary school students during the Covid-19 pandemic. The method in this study uses a descriptive qualitative analysis approach. The results show that the experimental method applied in elementary schools can increase the activity and learning outcomes of sixth grade elementary school students during the Covid-19 pandemic, because it can add new knowledge, is not easily bored with online learning, and can be useful for learning activities science in elementary school. Therefore, we can improve the activities and learning outcomes of elementary school students by strengthening literacy, especially in scientific literacy.

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1. INTRODUCTION

In general, the learning methods in elementary schools tend to be Teacher Oriented, namely teacher-centered learning. The Tradition is Teacher Oriented still widely used by teachers so that it does not empower students. This causes a low level of success in students in the learning process (Mayangsari *et al*., 2014). The difficulties experienced by students are also caused by the fact that teachers use the lecture method more often in the learning process, resulting in students being easily bored and bored during the learning process. Added with the Covid-19 pandemic which requires students to carry out learning activities online, where the delivery of material through virtual classes tends to affect the development and activity of students during the learning process. Based on observations, students only receive materials and assignments without any assistance from the teacher which should also be done even though it is online (Hidayah *et al.*, 2020). Teachers should use appropriate learning methods and strategies in accordance with the characteristics of students, so that they can help students understand the concept of learning as a whole.

Scientific process is a scientific activity carried out in order to find scientific products. The scientific process includes observing, classifying, predicting, designing, and carrying out experiments (Supiyatun, 2015). Applying the experimental method in learning activities aims to explore the curiosity of students and be able to grow a rational and scientific way of thinking so that the results of experiments can be accepted as scientific products while the steps in their implementation are scientific processes. The experimental method in learning is a way of presenting learning that allows students to conduct experiments to prove themselves a question or hypothesis being studied (Mayangsari *et al*., 2014; Mari *et al*., 2014). That the experimental method is a very effective teaching method because it helps students to find answers on their own based on the correct facts (data) (Syahputra *et al*., 2020). The experimental method is one way of teaching, where students conduct an experiment about something, observe the process and write down the results of the experiment, then the results of the observations are conveyed to the class and evaluated by the teacher (Mayangsari *et al*., 2014; Mari *et al*., 2014; Usber & Utami, 2015).

Implementation of experimental learning always requires the use of actual tools, because the essence of this learning is to try something object. Therefore, in the process always prioritize student activities so that the teacher's role tends to be more as a guide and facilitator (Mayangsari *et al*., 2014). The experimental method has advantages, including: (a) arouse students' curiosity, (b) arouse students scientific attitudes, (c) make learning actual, and (d) foster group study habits. as well as individuals. There are also disadvantages when applying the experimental method, including: (a) it requires quite a lot of tools and costs, (b) it takes a relatively long time, and (c) very few schools have experimental facilities. From the advantages and disadvantages of the experimental method that have been mentioned, the teacher as a facilitator is able to overcome it so that the learning process is not disrupted and student learning outcomes reach the maximum value (Mayangsari *et al*., 2014).

The experimental method is strengthened by the other study that the results of the study show that student learning activities through the experimental method have increased from cycle I to cycle II. The results of the observation showed that the average percentage of student learning activities in the first cycle was 65.53% (active category), increased in the second cycle by 80.6% (very active category), so that it increased by 15.07% and the other study too say that the results of the study showed that there was an increase in the average learning activity after being given experimental learning methods to sixth class students of Semester I Elementary School 3 Ngadirojo in the 2018/2019 academic year of 8.31 (Kusmaharti, 2021).

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Based on previous studies that have successfully applied the experimental method. Therefore, we conducted research with the aim of seeing the extent to which the experimental method applied in learning could improve the activity and learning outcomes of sixth grade elementary school students during the Covid-19 pandemic.

2. THEORITICAL FRAMEWORK

2.1. Lime

Lime is a type of citrus geruk. Lime is a type of ferdu plant that has many branches and twigs. **Table 1** shows the scientific classification of limes.

In lime there are many one chemical. Chemical elements contained in lime, namely citric acid, amino acids (tryptozan, lysine), essential oil, resin, glycosides, citric acid, fat 0.1 g, calcium 40 mg, phosphorus 22 mg, iron 0.6 mg, sulfur, vitamin B1 0.04 mg, vitamin C 27 mg, 0.8 g protein, and water 86 gr. The chemical content contained in limes can be converted into electrical energy. This is determined by the anode and cathode contained in lime. The anode in the form of a coin is plugged into the base of the lime, while the cathode in the form of a zinc plate is plugged into the bottom of the lime. In addition, wires that have been wrapped around paper clips are used to connect the anode and cathode of the lime to one another. Then the anode and cathode are connected to the legs of the LED lamp, so that the LED light is on. This happens because there is an electrolyte solution contained in the lime juice (Syahputra *et al*., 2020). **Figure 1** shows the working system of the alternative energy source used, namely lime.

Fruits containing acidic substances can produce electrical energy if metal is attached to the fruit. In addition to containing a lot of acid, fruit also contains a lot of water. If the fruit is paired with different types of metal, a potential difference will arise between the metal and water so that it can produce an electric current (Atina, 2015).

Table 1. Classification of scientific lime.

Scientific Classification	
Kingdom	*Plantae*
Divisio	*Magnuliophyta*
Class	*Magnolippsida*
Order	*Sapindales*
Family	*Rutaceae*
Genus	*Citrus*
Species	*aurantifolia C.*

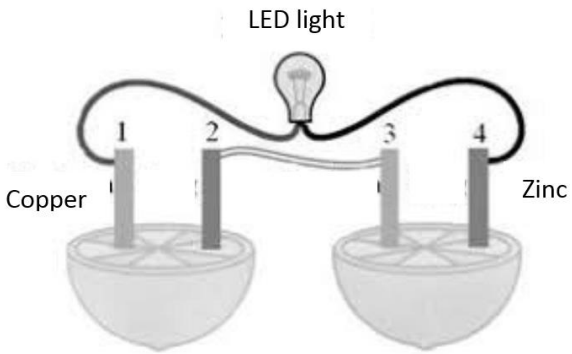

Figure 1. Lime alternative energy source work system (Syahputra *et al*., 2020).

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2.2. Energy Sources

Energy sources are everything that is around and capable of producing energy. One example of an energy source is electrical energy (Sintiya & Nurmasyitah, 2019). The source of electrical energy comes from non-renewable and renewable natural resources. Natural energy sources that cannot be renewed, for example fossil energy, are decreasing every year in the world and in Indonesia. The decline was due to an increase in population and economic growth. Renewable energy sources have become people's expectations to meet energy needs. Renewable energy in its availability is considered abundant and environmentally friendly, so that it can play a main role in the world's and Indonesia's energy supply (Kamilah *et al.*, 2020).

2.3. Electrical Energy

Electrical energy is the energy needed for electrical equipment. The energy produced comes from various sources such as water, oil, coal, coal, sun, and others. This energy ranges from a few volts to thousands or even millions of volts (Sintiya & Nurmasyitah, 2019). Electrical energy is energy that is the main need for humans in the digital age, which is very dependent on electrical energy to meet the needs for activities, such as obtaining information through electronic devices and household activities, such as lighting sources in the house. (Kamilah *et al*., 2020).

2.4. Alternative Energy

One of the solutions that can be done to deal with the energy crisis and maintain energy availability is through the use of alternative energy derived from materials that are available in everyday life and have not been widely used. Alternative energy is an environmentally friendly energy that can be renewed through the use of organic waste, such as vegetables and fruits (Sintiya & Nurmasyitah, 2019). Alternative energy is the practical use of energy produced. Organic materials and inorganic materials have the potential to be used as alternative energy. Alternative energy has a lot of availability and is environmentally friendly. In addition, materials that can be used as alternative energy sources can also support energy needs, especially for rural residents in low-income countries. Alternative energy is also widely found in vegetables and fruits (Markandya & Wilkinson, 2007; Yasa *et al*., 2021). Alternative energy is a term used for energy sources that can replace fossil energy or conventional energy. Alternative energy is also called renewable energy, green energy and clean energy. Alternative electrical energy can be generated from the use of fruits, vegetables, and bio-waste (Kamilah *et al.*, 2020; Yasa *et al*., 2021).

3. METHODS

The method used in this research is a descriptive qualitative analysis approach method, because it describes how a learning technique is applied and how the desired results can be achieved. The sample in this study were 10 students who were occupying the sixth grade of elementary school and is located in a state sixth public Elementary School Periuk. Then we selected a sample from the population and obtained as many as 10 sixth grade elementary school students with details of 50% males (5 students) and 50% females (5 students) with an average age of 11 years.

Data collection techniques in this study using pre-test and post-test instruments containing 10 questions regarding the use of lime as an alternative source of electrical energy and mentoring for sixth grade elementary school students to find out directly related to increasing

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student activity and learning as well as success or failure application of experimental methods during the Covid-19 pandemic. Pre-test questions in the form of (Yes/No) and post-test questions in the form of descriptions. The stage is that teaching is carried out online via Zoom meetings and takes approximately 40 minutes. then given pre-test questions and given reinforcement through material and video demonstrations. After that, apply the experimental method and the last stage is filling out the post-test.

4. RESULTS AND DISCUSSION

4.1. Demography

At the time of the study, there were aspects of students' abilities that could be assessed including aspects of communication, skills, concentration, social interaction, and academics. This information can explain the extent to which students' intellectual abilities and development can be used as a basis for carrying out the teaching and learning process.

The academic condition of 10 students who were randomly selected showed that 9 students had good concentration, communication, and social interaction skills and 1 student had poor concentration, communication, and social interaction skills. However, during the Covid-19 pandemic, the 10 students in terms of skills had decreased abilities during online learning because they rarely carried out activities related to practice, so their psychomotor abilities were reduced. **Table 2** shows the data of sixth grade elementary school students.

4.2. Phenomena In The Learning Process

From the students demograpgy data, its is found some complexity in the academic aspect, especially in the learning process. During the learning process, many phenomena occur in online learning which is carried out via Zoom meetings. These things can be summarized as follows. **Figure 2** shows the stages of the data collection process.

The learning stages carried out are as follows:

(i) First, students were asked to fill out pre-test questions through a Google Form related to alternative electrical energy sources.
(ii) Then were given an explanation of the material for electrical energy sources using powerpoint media and demonstration videos related to the material, namely the use of lime as an alternative source of electrical energy.
(iii) Then students are expected to be able to carry out experiments such as those contained in the demonstration video and reported in video form.
(iv) Next, the students were asked to fill out the post-test questions via Google Form.

Table 2. Data for sixth grade elementary school students'.

Initial Name	Age (Years)	Gender	Class
CLR	11	Female	VI A
ASP	12	Female	
AA	11	Female	
ST	11	Female	
ZF	11	Male	
BA	11	Male	
ZAM	12	Male	
FLAB	11	Female	
AMB	12	Male	
BPA	11	Male	

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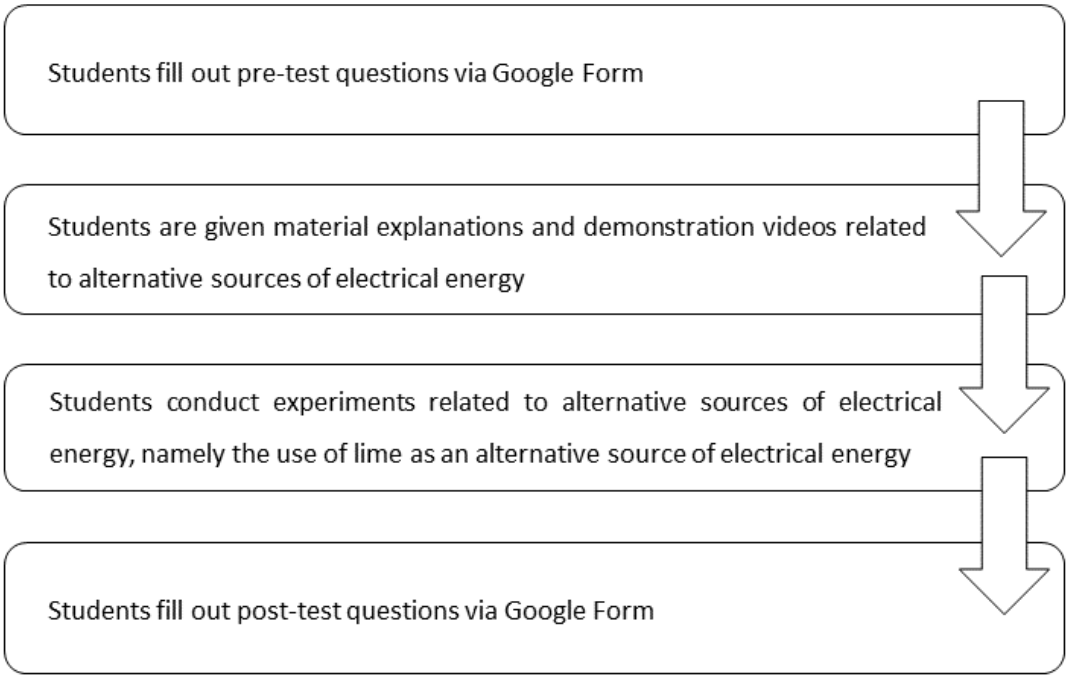

Figure 2. Stages during the learning process.

4.3. Pre-Test and Post-Test Results Sixth Grade Elementary School Students'

Based on the results of the pre-test that has been given to sixth grade elementary school students, **Table 3** shows that the average answer of sixth grade elementary school students in answering the pre-test questions gives an answer of "Yes" which indicates that they have quite understood the material related to the source alternative electrical energy. However, there are several "No" answers from sixth grade elementary school students which indicate that some sixth grade elementary school students have not been able to understand the material related to alternative electrical energy sources. Therefore, we carried out treatment by providing materials related to alternative sources of electrical energy to sixth grade elementary school students using power point and Google Meet media to assist during online learning and providing demonstrations to sixth grade elementary school students regarding the use of lime as an alternative source of electrical energy.

After sixth grade elementary school students received treatment through online learning about alternative electrical energy sources and saw demonstrations related to the use of lime as an alternative source of electrical energy, sixth grade elementary school students were able to fill out post-test questions. The post-test questions given to sixth grade elementary school students are in the form of descriptions, so that elementary school students think more critically about the material that has been discussed and to ensure that sixth grade elementary school students can fully understand the material of alternative electrical energy sources. So that the results of the post-test descriptions are shown in **Table 4**-**13** that student learning outcomes elementary school improved based on the answers to the post-test questions. Sixth grade elementary school students can answer post-test questions properly and correctly, especially seen from the description answers shown in **Table 13** that on average elementary school students have been able to think critically about the design of simple experiments on alternative sources of electrical energy that they will do.

In addition, when conducting online learning and giving demonstrations to sixth grade elementary school students regarding the use of oranges as an alternative source of electricity through Google Meet, we invite sixth grade elementary school students to participate in

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conducting experiments on the use of lime as an alternative source of electrical energy done at home with parental assistance. Through the application of the experimental method, the teacher must provide opportunities for students to practice or conduct experiments as evidence that the competency standards to be achieved have been implemented. The experimental method of the learning process is to involve students physically and mentally so that learning outcomes are more durable (Rismawati *et al*., 2016). The essence of this experimental method is that it is used to help students find their own concepts through experiments. With the application of this method, students are expected to be fully involved in planning experiments, conducting experiments, finding facts, collecting data, controlling variables, and solve real problems (Rismawati *et al*., 2016). The form of the report that the sixth grade elementary school student has participated in the experiment is in the form of video documentation. Applying the experimental method in learning activities aims to explore the curiosity of students and be able to grow a rational and scientific way of thinking (Mayangsari *et al*., 2014). This is proven true, because research shows that applying the experimental method to sixth grade elementary school students can increase curiosity and foster scientific attitudes of sixth grade elementary school students when conducting the experiment. In addition, judging from the attitude of the sixth grade elementary school students after applying the experimental method in learning, the sixth grade elementary school students became more pro-active in terms of class discussions and when conducting experiments, more critical thinking, and the development of creativity and skill in doing things. So it can be said that the experimental method can not only improve the learning outcomes of sixth grade elementary school students, but also increase the learning activities of sixth grade elementary school students during the Covid-19 pandemic. In line with research conducted by (Sutarjo, 2013) that an increase in the application of experimental methods to improve student learning activities can be seen in teacher activities in learning. Based on the classroom action assessment procedure which was carried out through two cycles, the increase in learning activities turned out to affect students' ability to understand learning material which was known through tests given in each action cycle and tests before the implementation of the first cycle (pre-cycle test). Just like what we do, the assessment procedure is seen through tests given using pre-test and post-test instruments regarding the material being studied.

Table 3. Pre-test sixth grade elementary school.

Questions pre-test	Results pre-test	
	Yes	No
Do you know what is meant by electricity?	93.3%	6.7%
Do you know what is meant alterative energy?	93.3%	6.7%
Do you know any alternative energy sources that can generate electricity?	93.3%	6.7%
Do you know any alternative sources of electrical energy besides batteries?	86.7%	13.3%
Can fruits be used as an alternative source of electrical energy?	86.7%	13.3%
Can limes be used as an alternative source of electrical energy?	86.7%	13.3%
Does lime have properties that can conduct electricity?	100.0%	0.0%
Do you know the content contained in lime?	86.7%	13.3%
Do you know what causes limes to be used as an alternative source of electrical energy?	86.7%	13.3%
Alternative energy is environmentally friendly energy, because it can be renewed through the use of organic waste such as vegetables and fruits. In your opinion, do alternative energy sources that produce electricity can be used as a solution for energy sources?	93.3%	6.7%

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Table 4. Results post-test number 1 sixth grade elementary school students'.

Questions post-test	
Explain what you know about electrical energy!	
Results post-test	**Quantity of students (person)**
Energy that is very useful for daily life	1
Main energy needed for electrical equipment / energy stored in electric currents	8
Electrical energy is energy that is the main need for humans to fulfill needs in activities, such as obtain information through electronic devices and household activities such as lighting sources in the house	1

Table 5. Results post-test number 2 sixth grade elementary school students'.

Questions post-test	
Explain what you know about alternative energy!	
Results post-test	**Quantity of students (person)**
Use of natural energy through natural processes continuously	1
All energy sources that can be used to replace fossil fuels without the negative impact of fossil fuels	6
Alternative energy is environmentally friendly renewable energy through the use of organic waste	3

Table 6. Results post-test number 3 sixth grade elementary school students'.

Questions post-test	
Explain the difference between electrical energy and alternative energy!	
Results post-test	**Quantity of students (person)**
Electrical energy is a core energy or source but alternative energy is a substitute energy	1
Alternative energy is a natural source of continuous natural processes. Electrical energy is the main energy needed by electrical equipment	1
Electrical energy is energy stored in electric currents while alternative energy is environmentally friendly	1
Alternative energy is an energy source that does not use materials from fossils while electrical energy is an energy which will always be produced from a source where the source will always create a new source and will always continue to be returned	3
Electrical energy is non-renewable energy and alternative energy is renewable	2
Alternative energy is a form of other energy source which is outside of fossil energy. For example, nuclear energy is part of alternative energy. Electrical energy is the main type of energy required for electrical equipment. The energy produced can come from various sources, such as water, oil, coal, wind, geothermal, nuclear, solar, and others	2

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Table 7. Results post-test number 4 sixth grade elementary school students'.

Questions post-test	
State the source of energy alternative that can generate electricity?	
Results post-test	**Quantity of students (person)**
Lime, waterfall, animal dung	2
Nuclear, petroleum, solar power, coal	6
Solar heat, water energy, wind	2

Table 8. Results post-test number 5 sixth grade elementary school students'.

Questions post-test	
Why is it not recommended to use alternative sources of electrical energy?	
Results post-test	**Quantity of students (person)**
Because it contains chemicals	1
Not environmentally friendly	1
Because if you use an alternative energy source battery, coal power plants or other power plants will decrease users	1
Because rare earth elements are needed to produce lithium-ion batteries rare and very expensive	1
Because it can't conduct electric current strongly	1
Because it's harmful to the environment	2
Because it can't be used anymore	1
Because after using a used battery the battery tube is thrown away and can become waste or garbage	1
Because alternative sources of electrical energy do not produce electricity sufficient at all times and in all weather conditions	1

Table 9. Results post-test number 6 sixth grade elementary school students'.

Questions post-test	
Mention at least 3 fruits that can be used as alternative sources of electrical energy?	
Results post-test	**Quantity of students (person)**
Lime, banana, lemon	2
Potato, lime, apple	2
Lime, potato, apple	1
Lime, mango, apple	1
Lime, apple, lemon	2
Orange, banana, mango	1
Lime, apple, banana	1

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Table 10. Results post-test number 7 sixth grade elementary school students'.

Questions post-test	
What are the chemical lime?	
Results post-test	**Quantity of students (person)**
Limonen (26.04%), citral (Neral) (10.40%), pinen (18.84%), citral (Geranial) (13.09%), and phellandren (6.29%)	1
Citric acid, amino acids, essential oils, resin, glycosides, citric acid, fat 0.1 grams, calcium 40 mg, phosphorus 22 mg, iron 0.6 mg, sulfur, vitamin B1 0.04 mg, protein 0.8 grams, water 86 grams	9

Table 11. Results post-test number 8 sixth grade elementary school students'.

Questions post-test	
Why can limes be used as an alternative source of electrical energy?	
Results post-test	**Quantity of students (person)**
Due to the chemical content in limes it can be converted into electrical energy in a series of voltaic cells	5
Because limes contain acid which has electrolyte properties so that it can produce electrical energy	1
Lime contains acidic juice which contains a lot of vitamin c, citric acid, amino acids, glycolic essential oil, citric acid, sulfur and vitamin b	4

Table 12. Results post-test number 9 sixth grade elementary school students'.

Questions post-test	
Name vegetables that can be used as an alternative source of electrical energy?	
Results post-test	**Quantity of students (person)**
Potato	4
Cabbage, potato, chili, carrot	1
Tomato	1
Potato, tuber leaf	2
Tomato, apple, potato	1
Potato, cucumber	1

Table 13. Results post-test number 10 sixth grade elementary school students'.

Questions post-test	
Design a simple experiment on alternative sources of electrical energy besides lime!	
Results post-test	**Quantity of students (person)**
Insert the coin and nail into the lime, we clamp the alligator clip on the coin and the nail, the red alligator clip cable is clipped to the nail and the black one is clamped to the coin	1

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Table 13 (Continue). Results post-test number 10 sixth grade elementary school students'.

Questions post-test	
Design a simple experiment on alternative sources of electrical energy besides lime!	
Results post-test	**Quantity of students (person)**
Alternative energy source from apples	1
To make electricity from potatoes, prepare the following materials: potatoes, LED lights (or small light bulbs are also possible, 1 m long cable, crocodile clips, copper (Cu) plate), plates of zinc (Zn). To replace copper and zinc, you can use the contents in a battery which is usually black. The steps of the potato experiment: (1) Insert the copper and zinc plates into the potato with a distance of a few centimeters (do not put them together), (2) Clamp the cable to each plate and connect it to the lamp, (3) See the light that occurs, (4) If the light is not visible, try turning it over, but if it does not work, please do not add the potato so that the electric current generated increases	7
Bananas, the energy value contained in it is calories. For every 100 grams of bananas, there are 136 calories, which if calculated is 2 times compared to apples	1

5. CONCLUSION

The conclusion of this study is that the sixth grade elementary school students have understood the material related to alternative electrical energy sources through understanding the material, instruments pre-test and post-test, and applying experimental methods in online learning activities. When the experimental method is applied in online learning, it can be said that the learning outcomes and learning activities of sixth grade elementary school students increase during the Covid-19 pandemic because it can add new knowledge, make elementary school students not bored when online learning, and can useful for science learning activities in elementary schools.

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7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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