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The Effect of Using Contextual STEAM-Based Electricity KIT in Improving Junior High School Students' Problem-Solving Ability on Dynamic Electricity Material

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Abstract

The study aimed to investigate the increase in problem-solving abilities of junior high school students after being treated using contextual STEAM-based electrical KIT in the experimental class and conventional learning in the control class. The research used a quasi-experimental non-equivalent control group design with the posttest-only control group design model. The population was class IX students of Muhammadiyah Middle School for the 2022/2023 academic year, with 71 students. The samples were selected using the simple random sampling technique, namely 47 students divided into class IX-1 as the control class and class IX-2 as the experimental class using a contextual STEAM-based electrical KIT. The results showed that the problem-solving ability of the experimental class was higher, namely obtaining an average score of 50.00% with sufficient criteria. Meanwhile, the control class only got an average score of 38.04% with poor criteria. Based on the inferential analysis using SPSS version 25 with a confidence level of 95%, the output of the independent t-test shows a significance of 0.009. It means that there is a significant difference between the problem-solving abilities of students who use contextual STEAM-based electrical KIT compared to students who use conventional learning.

INTRODUCTION

The 21st century is an age of rapid knowledge and technology, which means education in the 21st century must be prepared to face various challenges. Tony Wagner, in Kurniawati et al. (2019), stated seven survival skills needed by students in life, work-related environment, carrying out responsibility as citizens and living together with the public in the 21st century, including critical thinking skills and problem-solving, cooperation, and leadership, skills, and abilities in adapting, initiative and entrepreneurial spirit, able to communicate effectively orally and in writing, find ways and analyze information, and have curiosity and vision. Problem-solving ability is very needed as, in daily activities, one will often encounter various problems that need to be solved and creativity to get a solution to these problems (Permatasari & Margana in Sumiantari et al., 2019).

Learning Natural Sciences (IPA) must be designed to make students understand deeply about the nature and environment. According to Taufik et al (2010), science learning must share direct knowledge with students which aims to improve their ability to construct, understand, and apply the concepts. Problem-solving ability is essential in science learning because problem-solving activities require students to acquire the concepts in learning themselves to achieve meaningful learning (Sumiantari et al., 2019). The importance of problem-solving skills in science learning is also contained in the 2013 curriculum, namely mastering the concepts and nature of science and its interconnections and application to solving problems in everyday life.

The results of the PISA survey in 2018 in the science category (IPA) place Indonesia in 71st place out of 79 participating countries with an average score of 396 (Schleicher, 2018). The OECD average score in the science category (IPA) is 489. The questions tested in the PISA are contextual, taken from everyday problems. This proves that Indonesian students are only used to working on simple problems with mathematical calculations or in the memorization stage, so they have difficulty solving complex questions. Rahayu et al. (2021) investigated low problem-solving abilities in science learning in students in class VII of MTs Asnawiyah Kab. Bogor. The average score for each indicator is 15.4% for the stage of understanding the problem, 21.1% for the stage of planning a strategy, 18.7% for the stage of implementing the strategy, and 5.6% for the stage of re-examining the correctness of the solution.

From previous research, Junior High School Muhammadiyah Kuok has poor student problem-solving skills, as seen from the monotonous learning process in class, and the questions do not yet contain indicators of problem-solving ability, especially in learning science. Also, the survey shows that science learning has not been able to improve student's problem-solving skills.

The learning approach is one of the most essential factors in the learning process. Appropriate selection of learning approaches can achieve effective learning. Teachers must apply interest and varied approaches to the learning process to share the best learning skills with students. According to (Turdjai, 2016), teachers may choose a learning approach that focuses on student participation, aiming for the students to find material and solve problems independently.

The learning process with the viewpoints of Science, Technology, Engineering, art, and Mathematics, commonly abbreviated as STEAM, will help real and interesting studies that aim to achieve cognitive, psychomotor, and affective aspects. STEAM is an approach or point of view in the learning process that integrates science, technology, engineering, art, and mathematics in solving problems. STEAM learning can increase the feeling of wondering, exploring, and thinking about the occurred, the reason, and the consequences of the phenomena that arise and trying to solve. Through this approach, students can immediately relate and find a way to a problem (Mu'minah & Suryaningsih, 2020).

Science learning emphasizes direct experience so that students can develop their abilities. The use of learning media is very effective in providing direct expertise to students. In the end, it helps students in interpreting the natural surroundings. One example of media in science learning is the electric kit. According to Ambai et al. (2014), the use of KIT in science learning can encourage students to develop their potential. The use of electricity KITs in schools is not yet contextual, so students are not able to implement the gained knowledge and skills in solving various daily problems. Based on a survey conducted at Junior High School Muhammadiyah Kuok, the use of KIT tools was rarely carried out in the learning process as some of the KIT tools were damaged and lost, which made students unfamiliar with KIT tools.

Dynamic electricity is part of the science material taught in junior high schools whose implementation is often found in students' lives. Andriani et al. (2015) argue that dynamic electric matter has symptoms and is often found in daily activities. Students find it difficult to understand because learning dynamic electricity material in the classroom is still abstract and complex. As a result, it needs a learning media to share real learning situations for students. This allows to use of contextual STEAM-based electrical KITs to achieve more real learning in the lives of students. Based on this explanation, the article carries out research with the title "The Effect of Using Contextual STEAM-Based Electricity KIT in Improving Junior High School Students' Problem-Solving Ability on Dynamic Electricity Material."

RESEARCH METHOD

This research was a Quasi-Experimental research. Experimental research is used to see the effect of giving certain treatments or actions on certain results or is referred to as a causal test, which can be interpreted as whether a treatment has an impact on the success factor to be studied (Setyosari, 2013). The research design was a nonequivalent-posttest-only control group design. There are two classes. First, the experimental class is the class that gets treatment using contextual STEAM-based electricity KIT. And, the control class does not get treatment (using conventional learning). The effect of the treatment between the two classes will then be compared. The Posttest-only Control Design scheme is presented in Table 1.

Table 1. Research Design of Posttest Only Control Group Design

Class	Treatment	Posttest
Experiment	X	O_1
Control		O_2

The research was conducted at Junior High School Muhammadiyah Kuok in the odd semester of 2022/2023. The research was conducted in October-December 2022. The population was 71 students of class IX at Junior High School Muhammadiyah Kuok for the 2022/2023 academic year. Samples were selected through a simple random sampling technique. 24 students of class IX-2 played as the experimental class treated using the contextual STEAM-based electricity KIT and 23 students of class IX-1 students played as the control class who were taught using conventional learning. The target of the research was students' problem-solving abilities after learning. The data of solving ability was selected using an objective test totaling 12 questions with 3 questions for each indicator. In this research, problem-solving treatment used Polya's theory as a reference. The question of problem-solving ability test has been tested for validity by experts.

In the study, the validity assessment by experts consisted of two lecturers. The two validators were asked to fill out a validation sheet. Furthermore, the data of assessment scores is converted into a Likert scale. Instrument items are categorized into four choices. Each measured indicator is given a score on a scale of 1-4, namely 4 (SS/"Strongly Agree"), 3 (S/"Agree"), 2 (TS/"Disagree"), 1 (STS/"Strongly Disagree") (Sugiyono, 2019). Then, the validity results can be calculated with the following equation.

$$X = \frac{1}{number\ of\ validators} x \frac{\sum x}{N}$$

Where:

X : mean score of each aspect
$\sum x$: aspek sum of scores obtained for each aspect
N : the number of indicators assessed on each aspect

The validity category of the question instrument, according to Sugiyono (2015), is presented in Table 2.

Table 2. Category of Question Instrument Validity

Interval of Score	Validity Level
$3{,}44 \leq X \leq 4$	Strongly Valid
$2{,}88 \leq X < 3{,}44$	Valid
$2{,}32 \leq X < 2{,}88$	Fairly Valid
$X < 2{,}32$	Invalid

The instrument is valid if all aspects of the assessment are in the range of $2.32 \leq X \leq 4$.

In the study, the data will be analyzed descriptively and inferentially into data analysis methods and techniques. The mean score of the post-test of students' problem-solving ability is explained by using descriptive statistical analysis. The results of students' problem-solving abilities were calculated using the following equation:

$$HKPM = \frac{Students's\ score}{Maximum\ Score} x\ 100\%$$

According to Syah in Nurfauziah & Zhanthy (2019), there are 5 categories of qualifications for calculating percentages which is presented in Table 3.

Table 3. Percentage of Problem Solving Achievement

Percentage	Predicate
$81 \leq HKPM \leq 100$	Very good
$61 \leq HKPM < 81$	Good
$41 \leq HKPM < 61$	Fair
$21 \leq HKPM < 41$	Poor
$HKPM < 21$	Very Poor

Inferential statistical analysis is used to investigate the initial picture or hypothesis with an independent t-test. Previously, a test was carried out to find out that the data met the requirements of normal and homogeneous.

RESULT AND DISCUSSION

The data of the study was quantitative, namely post-test scores of students' problem-solving abilities. The instrument of the posttest item has been tested for validity with a value of 3.70 with a strongly valid on the content aspect, 3.88 with a strongly valid for the construct aspect, and 3.38 with a valid for the language aspect. Then, the item questions were feasible to use. After learning, both two classes were tested for problem-solving abilities. Data descriptions are presented in Table 4 and Figure 1.

Table 4. Description of the Mean Score of Students' Problem Solving Ability for Each Indicator

No	Indicators of Problem-Solving Ability	Mean Score of the Experimental Class	Criteria	Mean Score of the Control Slass	Criteria
1	Understanding the Problem	75.00	Good	68.12	Good
2	Planning the Problem Solving	19.44	Very Poor	10.14	Very Poor
3	Carry out the problem solving	48.61	Fair	47.83	Fair
4	Re-Examining the Solution	56.94	Fair	26.09	Fair
Mean score		50.00	Fair	38.05	Poor

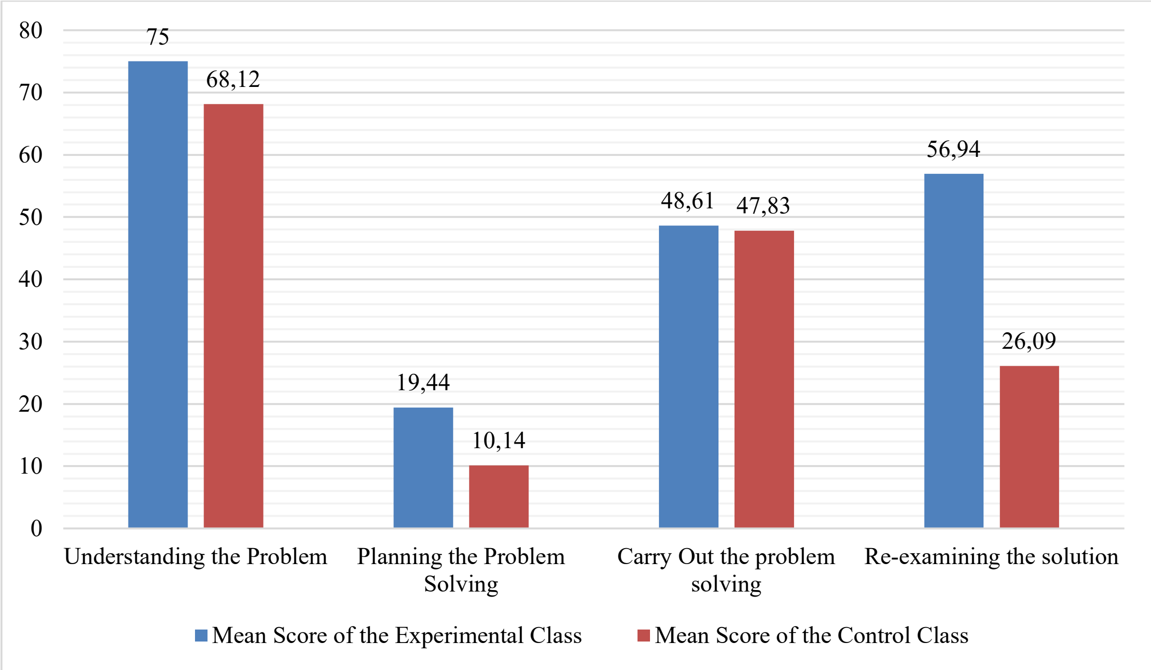

Figure 1.Graph of Posttest Total Score of Students' Problem Solving Ability

Indicators of problem-solving ability consist of four indicators, namely understanding the problem through seeking as much information as possible, planning problem-solving by simplifying the development of patterns and models, carrying out problem-solving using strategies, and re-examining solutions according to basic concepts. Analysis of the post-test scores of students' problem-solving abilities for both classes is presented in Figure 2.

Figure 2. Graph of Analysis of Posttest Scores on Each Problem Solving Question Item

An explanation for each indicator of students' problem-solving abilities will be explained below:

1. Ability to Understand the Problems

At this stage, students are asked to recognize and examine the problems found. So, real problems can be understood by students. The questions item are identifying known quantities and being asked through pictures and support students in presenting the information. In line with Sujarwanto et al. (2014), problem-solving ability is a student's effort to get information for the best solution through the maximum implication of his abilities. There are three questions, namely the first, second, and third questions. Figure 2 shows the mean score of the experimental class was 75.00% of the good category. In contrast, the control class obtained a mean score of 68.12% in the good category. Anwar (2013)) argues that a good understanding is an important step in solving problems, and mistakes in understanding questions can have an impact on unresolved questions.

2. Ability to Plan Problem Solving

At this stage, students are asked to design a planning concept to solve problems, namely by determining the appropriate strategy to resolve the problem. Questions item that describes a problem can help students to simplify a problem and design. The questions item on this indicator are presented in the form of a problem statement. Then, students are required to find a planning solution by developing certain models. Also, there are three question items, namely questions fourth, fifth, and sixth. In Figure 2, the mean score of students' abilities was 19.44% for the experimental class and 10.14% for the control class. Both classes are in the criteria of very poor ability.

The factor of students' low scores is the difficulty in relating the knowledge and the problem being asked about other concepts. Dewi et al. (2018) stated that, for the problem to be solved, an understanding of the concept is needed to become the initial requirement and expertise in connecting one concept to another because understanding the concept influences the way students solve problems.

3. Ability to Carry out the Problem Solving

At this stage, students are asked to carry out the plan by matching the various problems of the question items. The questions are in the form of presenting a problem. Then, students carry out the solution using a strategy. Anwar (2013) states that in solving the Polya problem, students are asked to connect questions with real contexts or experiences. It means that they do not only memorize material. And, there are three questions, namely the seventh, eighth, and ninth. In Figure 2, the mean score of students' abilities was 48.61% for the experimental class and 47.83% for the control class. And, both classes are on the fair ability criterion.

4. Ability to Re-examining Solutions

At this stage, students are asked to review the validity of the results and units, conclude answers, and assess and re-examine the answers following the concept. Anwar (2013), the activity of re-examining the solution aims to see whether the answers follow the concept, make sense, and no other process of obtaining answers. And, there are three questions, namely the tenth, eleventh, and twelfth. Figure 2 concluded that the mean score of students' abilities was 56.94% in the experimental class with fair criteria and 26.09% in the control class with poor. There is a big difference between the mean scores of the experimental and the control class because it uses an electrical KIT tool with a contextual STEAM approach, which makes the students more interested and building their understanding of concepts.

Data of the post-test of students' problem-solving abilities after the implementation of contextual STEAM-based electricity KIT for the experimental class IX-2 and conventional learning for the control class IX-1 on dynamic electricity material is presented in Table 5.

Table 5. Description of the Number of Students Based on the Results of the Problem Solving Ability Test

Percentage	Predicate	Experiment Class		Control Class	
		Number of Students	Percentage (%)	Number of Students	Percentage (%)
$81 \leq x \leq 100$	Very Good	0	0.00	0	0.00
$61 \leq x < 81$	Good	4	16.67	0	0.00
$41 \leq x < 61$	Fair	15	62.50	12	52.17
$21 \leq x < 41$	Poor	4	16.67	7	30.43
$x < 21$	Very Poor	1	4.17	4	17.39

Data on problem-solving abilities were analyzed and found that there were no students who received very good predicates for both control and experimental classes. In the experimental class, several students were in a good predicate. In contrast to the control class, there were no students who got a good predicate and most students got fair criteria.

Inferential analysis was assisted by SPSS version 25. Based on the Independent Samples Test output, a significance (2-tailed) of 0.009. As 0.009 <0.05, then H0 is rejected. It means that there is a significant difference in the student's problem-solving abilities in the experimental class using contextual STEAM-based electrical KIT compared to the control class using conventional learning. Thus, the use of a contextual STEAM-based electrical KIT influences students' problem-solving ability in the experimental class and an alternative solution that makes differences between the two classes. In line with Dewi et al. (2018), learning using STEAM as a point of view can improve students' problem-solving abilities. In another study conducted by Harefa & Laia (2021), the use of media can improve students' problem-solving abilities. The use of media greatly supports the enthusiasm and relationship between students and teachers in the classroom.

CONCLUSION

Based on the findings and discussion on the use of contextual STEAM-based electricity kits in class IX at SMP Muhammadiyah Kuok, it concluded that:

1. At the understanding stage, students meet the good criteria. At the planning stage, students' abilities were poor. At this stage of the problem-solving process, students' skills meet fair standards. At the stage of re-examining the solution, the student's ability was fair.
2. Students' problem-solving abilities differed significantly between the experimental class that used contextual STEAM-based electricity KIT and the control class that used conventional learning on dynamic electricity material.

Learning with KIT electricity with a contextual STEAM approach can be interpreted as a way to train students' problem-solving abilities at school.

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