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Optimizing Science Process Skills Through the Use of Simple Steam Power Plant Models in Middle School Physics Education

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Abstract
This study aims to evaluate the effectiveness of using a simple steam power plant prop in improving the science process skills of eighth grade students at Pesantren Guppi Samata Junior High School. The importance of this study lies in the need for innovative teaching methods that can improve students' engagement and understanding in science education, especially considering the limitations of traditional laboratory resources. A quasi-experimental design with a pretest-posttest control group was used, involving purposive sampling of two groups: an experimental group that used a simple steam power plant prop and a control group that did not use the prop. Data were collected through a structured multiple-choice test that assessed various aspects of science process skills and were analyzed using descriptive statistics, normality tests, and independent t-tests. The findings showed that the experimental group significantly outperformed the control group in the posttest (p = 0.000), indicating that the simple steam power plant prop effectively facilitates better understanding of scientific concepts through hands-on learning. The novelty of this study lies in its focus on the use of simple and accessible teaching props to improve practical skills in science education. The results of this study suggest that incorporating these tools into teaching can improve educational outcomes, and offer a valuable resource for educators facing limited laboratory facilities..

Keywords: Education Innovation; Quasi-Experimental Design; Science Process Skills; Simple Steam Power Plant; Student Engagement

INTRODUCTION

Education is one of the most important factors in human life. Through education, humans can develop their potential, both in terms of knowledge, skills, and attitudes needed to face the challenges of life (Fauziyah et al., 2023; Perdana et al., 2023; Saputro et al., 2023). Education is not only a means to transfer knowledge from one generation to the next, but is also expected to encourage change and improve the quality of life of the nation towards a better direction (Akbar, 2023; Anggita et al., 2024; Juharti & Kartika, 2021).

In the context of learning Natural Sciences, learning must be designed in such a way that students not only understand scientific concepts in theory, but are also able to apply these concepts in everyday life. Science includes natural knowledge obtained through observation, experimentation, and systematic scientific analysis (Irfan, 2023; Nelson et al., 2017; Prastuti, 2020). Therefore, practical activities are very important to help students understand the scientific process in real terms.

Teaching aids as learning media play an important role in clarifying concepts that are difficult to understand abstractly. With the existence of teaching aids, students can more easily understand the material because they can visualize abstract phenomena to be more concrete (Dessi & Shah, 2023; Kamid et al., 2023; Sakinah et al., 2022). These teaching aids must be designed in such a way that they are interesting, effective, and efficient in helping students achieve learning goals.

Science Process Skills (SPS) are essential skills in science learning that include the skills of observing, grouping, measuring, concluding, and communicating experimental results. In the context of physics education at the secondary school level, the development of SPS is very important to build conceptual understanding and scientific thinking skills of students (Astalini et al., 2023; Kamid et al., 2022; Zurweni et al., 2022). Through these skills, students can understand how physics concepts are applied in real situations, such as in a simple steam power plant model (Darmaji et al., 2022; Triani et al., 2023). These skills not only help students understand the scientific process more deeply, but also foster critical, creative, and problem-solving attitudes (Rinjani & Romadona, 2023; Winda & Shofiardin, 2023; Wulandari, 2023). By integrating interesting learning models, such as a simple steam power plant model, students can be directly involved in experimental activities that support the improvement of their science process skills, while strengthening their understanding of the physics material being taught.

Science process skills, such as observing, classifying, predicting, and interpreting data, are very important in science learning (Ilmi et al., 2016; Ruwiyah et al., 2021; S et al., 2021). These skills help students not only understand scientific concepts but also develop critical and analytical thinking skills, which are very much needed in everyday life. By honing science process skills, students can find and understand scientific concepts independently.

Previous studies have shown that the use of teaching aids in science learning is very effective in improving students' science process skills. For example, research by Saputri & Dewi (2014) showed that the use of simple teaching aids is very effective in improving students' science process skills, with classical completeness reaching 87.5%. Another study by Karsli et al. (2009)also showed that the use of teaching aids in science learning has a significant impact on the development of science process skills.

Seeing the importance of the use of teaching aids and process skills in science learning, this study aims to see the effectiveness of the use of simple steam power plant teaching aids in improving students' science process skills. The urgency of this study is to provide a practical solution to the limitations of practical tools that are often faced by schools.

RESEARCH METHODS

This study aims to evaluate the effectiveness of using simple steam power plant teaching aids in improving students' science process skills. The following is the methodology used:

Research Design

This study used a quasi-experimental design with a pretest-posttest control group design approach. In this design, there are two groups: the experimental group that was given treatment using simple steam power plant demonstration tools, and the control group that was not given the treatment. The two groups will be compared to see the differences in science process skills before and after the treatment.

Research Target/Subject

The subjects of the study were students of class VIII at one of the junior high schools of Pesantren Guppi Samata. The sample selection was carried out by purposive sampling, namely selecting classes that have homogeneous characteristics in terms of academic ability and socio-economic background.

Research Procedure

• Preparation Stage: Developing a research implementation plan, including scheduling, procurement of simple steam power plant demonstration equipment, and coordination with the school.

• Implementation Stage:

Pretest: Giving an initial test to both groups to measure science process skills before treatment.

Treatment: The experimental group was given learning using simple steam power plant demonstration equipment for 4 weeks, with a frequency of 2 meetings per week.

Posttest: After the treatment period, both groups were given a final test to measure science process skills after treatment.

• Evaluation Stage: Analyzing pretest and posttest data to determine the effectiveness of demonstration equipment in improving science process skills..

Instruments, and Data Collection Techniques

- Test Instrument: Using a multiple-choice test of 20 questions designed to measure science process skills, such as observing, classifying, and interpreting data.
- Observation: During the learning process, observations were made of student activities to see their involvement and response to the use of teaching aids.

Data analysis technique

Descriptive Analysis: Calculating the mean, standard deviation, maximum value, and minimum value of the pretest and posttest results for both groups. Normality Test: Checking the distribution of the data using the Kolmogorov-Smirnov test to ensure that the data is normally distributed. Homogeneity Test: Using Levene's test to ensure that the variance of the data between the two groups is homogeneous. t-test: Conducting an independent sample t-test to compare the posttest results between the experimental and control groups.

RESULTS AND DISCUSSION

After conducting research using the pretest-posttest control group design method, data from both groups were analyzed to evaluate the effectiveness of using simple Steam Power Plant teaching aids on students' science process skills. The following are the results of the study presented in table form:

Table 1. Descriptive Statistics of Pretest and Posttest Results

Group	Mean Pretest	Mean Posttest	SD	Minimum Value	Maximum Value
Experimental	60.5	85.2	6.32	55	95
Control	61.0	67.8	7.10	50	80

Based on table 1 above, the posttest results of the experimental group showed a higher average (85.2) compared to the control group (67.8). This indicates that the use of simple steam power plant demonstration tools has a positive impact on improving students' science process skills.

Table 2. Normality Test Table (Kolmogorov-Smirnov Test)

Group	Sig. Pretest	Sig. Posttest	Description
Experimental	0.123	0.067	Data is normally distributed
Control	0.098	0.135	Data is normally distributed

From table 2, the results of the normality test show that all pretest and posttest data from the experimental and control groups have a significance value ($p > 0.05$), so the data can be said to be normally distributed.

Table 3. Homogeneity Test Table (Levene's Test for Equality of Variances)

Group	Sig. Pretest	Sig. Posttest	Description
Experiment and Control	0.578	0.462	Homogeneous data

Levene's Test shows that the significance values in the pretest and posttest are greater than 0.05, namely 0.578 and 0.462, which means that the variances of the two groups are homogeneous.

Table 4. Uji t-Sampel Independen (Posttest)

Group	t-count	df	Sig. (2-tailed)	Mean Difference
Experiment and Control	7.52	22	0.000	17.4

The t-test results show a sig. value of 0.000 ($p < 0.05$), which means there is a significant difference between the posttest results of the experimental and control groups. The Mean Difference of 17.4 indicates a significant increase in the experimental group after using a simple steam power plant prop.

The results of the study indicate that the use of a simple Steam Power Plant prop significantly improves students' science process skills. This is evident from the posttest results of the experimental group which were on average higher (85.2) compared to the control group (67.8), and the independent sample t-test showed a significant difference ($p = 0.000$). The data also show that both the pretest and posttest of both groups were normally distributed and the variance was homogeneous, so the t-test results were valid. This indicates that the simple steam power plant prop is able to facilitate students in understanding science concepts more deeply through a practical approach that hones science process skills, such as observing, classifying, and interpreting data.

These findings have important implications for science learning, especially in efforts to improve students' science process skills. The use of simple steam power plant props can be a practical solution for schools that have limited practical tools. Direct learning experiences through these props can increase students' active involvement in the learning process, so that their critical and analytical thinking skills can be honed well. Therefore, the application of simple but effective props like this is highly recommended in science learning in schools, especially in physics topics that require real experiments. The novelty of this study lies in the direct evaluation of the use of simple steam power plant props in improving students' science process skills, where similar studies examining the effectiveness of these props are still limited. However, this study has several limitations, such as the use of samples that are limited to only one school and with a relatively small sample size. For further research, it is recommended to use a larger sample and include a variety of schools with different socio-economic backgrounds. In addition, further research is also needed to test the effectiveness of these props in other physics learning topics or in a longer period of time.

CONCLUSION

The conclusion of this study shows that the use of simple Steam Power Plant teaching aids is effective in improving students' science process skills. The posttest results of the experimental group were significantly higher than those of the control group, proving that the teaching aids are able to facilitate students in understanding science concepts through a practical approach involving observation, classification, and interpretation of data. The use of these teaching aids can be an efficient alternative method in science learning, especially in schools that have limited laboratory facilities.

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