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Application of Project-Based Learning (PjBL) Models Assisted with Teaching Aids to Improve Students' Science Process Skills on Work and Energy Materials

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Abstract
This research aimed to assess if MAS Syamsuddhuha's application of the PjBL model has increased the efficiency of the student's training processes. This analysis is a quasi-experimental design analysis. The subjects of this research are students from grades X IPA 4 as the experimental class and X IPA 5 as the control class. During the experiment, the experimental class used the PjBL model with teaching aids, whereas the control class used the PjBL model during the teaching process. The design method used in this study is called nonequivalent control group design. Instrumental research tools in the form of tests and observation sheets are used to observe students' science process skills. The hypothesis uses a non-parametric test for the post-test sample rate. The results showed that the post-test experimental class score was 81.19, and the control class post-test score was 66. Applying the PjBL model with teaching aids has increased students' science process skills in work and energy.
Keywords: Project Based Learning (PjBL) Model; Science Process Skills; Teaching Aids

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INTRODUCTION

The education system in the world continues to change significantly, causing a change in the mindset of students from ordinary, rigid thinking to an advanced mindset. Education is the basis of the progress of a nation, in which the nation's education will produce quality human resources. So that with education, humans will gain knowledge useful for the homeland and the nation, especially the community, both intellectually, emotionally, and spiritually (Bada & Olusegun, 2015; Biesta, 2015).

Since 1945 the curriculum in Indonesia has gone through various updates and improvements. Updates are carried out with developments, be it increasingly sophisticated technological developments, student growth, and needs that must be met. Changes that occur in the curriculum can produce good results in any improvement. So, the curriculum changes that occurred then became the 2013 curriculum. The learning process in the 2013 curriculum was fully developed in three areas (cognitive, affective, and psychomotor), meaning that all three cannot be separated from other domains. It is hoped that using the 2013 curriculum will change the learning system in Indonesia because the 2013 curriculum has the skills students need to improve their learning objectives, particularly in physics lessons and science process skills.

Students need to be able to use scientific processes to compete in the current world. Students need to have the ability to use science process skills to compete in the current world (Budiyono & Hartini, 2016; Prahani et al., 2021; Zainuddin et al., 2020). As stated by the world of education, developing skills in the science process will develop basic skills, such as students' scientific attitudes and problem-solving skills, to develop students to be creative, competitive, innovative, and open to criticism in the global society. Students' learning results in science are poor because of their insufficient science process skills.

Process skills aproach are a learning approach designed so that students can find facts and construct concepts and theories in the learning they receive. Students are encouraged to participate in scientific activities during the learning process. Physics is the study of natural phenomena. Physics is also one of the basic sciences that every individual must master daily. Learning physics is learning that employs the scientific method's phases. The method of education physics is very important to learn and master science process skills because students do learning not only to achieve results but to familiarize students with scientific learning. Physics learning emphasizes science process skills that students need as preparation and practice in facing the realities of life in society because students are required to think logically in solving problems (Nadia et al., 2021; Nurhuwaida et al., 2022; Nurtang, 2020). Science process skills can foster knowledge, attitudes, and self-confidence. Teachers must be able to use learning models and media according to current educational needs to assist students in comprehending the content taught by the teacher more simply and can enhance students' knowledge of the scientific method, specifically when employing the PjBL learning paradigm.

Based on observations and interviews with one of the tenth-grade physics teachers and students at MAS Syamsuddhuha, information was obtained that the physics learning applied in the school was still conventional, as it still used the lecture method. Therefore, students tend to be passive in the learning process and only get what the teacher explains without understanding the concepts in everyday life. Then the learning process in class has not fully utilized students' science process skills. Such as the lack of learning media in the learning process in the classroom as well as practicum and experimental activities that are not fully used so that students' science process skills do not develop. Therefore, learning is needed to train students' science process skills and improve students' abilities in the cognitive domain, namely with solutions using the PjBL model for science process skills and according to the steps. So the researchers took the title of applying the PjBL model assisted by visual aids to improve students' science process skills.

The learning model in the 2013 curriculum, namely the PjBL learning model, offers pupils chances for learning and problem-solving (Jalinus & Nabawi, 2017; Kusumaningrum & Djukri, 2016; Serin, 2019). The PjBL learning model offers opportunities for educators to control student learning in the classroom and involve students in project work. Project work is a task that follows the problems given to students as an initial stage to collect and acquire new knowledge according to students' experience (Mulyadi, 2016). The teacher requires this PjBL learning model and pupils to participate actively in their education. Therefore, it is necessary for learning media in this PjBL learning model to utilize teaching tools. Teaching aided by instruction has a very important role as a media tool to create an effective learning process (An'nur et al., 2020; Pranata, 2016). The teaching and learning process uses teaching tools Learning is aided by instruction in the teaching and learning process (Prasetyarini et al., 2013). So it can be concluded that teaching aids can be used as a tool in the learning process so that students easily understand the contents of the teacher's material. The teaching aids in this study were self-designed using existing tools and materials around the environment that can be used to practice the material at a low cost, a relatively short time, and do not require special expertise in the use of tools and materials. So that by using teaching aids, students' science process skills will be more developed. Science process skills can be improved through the PjBL model assisted by visual aids because apart from being faced with problems, students are also required to find solutions by completing a project so that student predictions and problems can be solved in real terms. In addition, process skills can also train students to be active and creative in the scientific learning process.

Based on research conducted in previous journals using the PjBL using a model with teaching aids, 1) The use of the PjBL paradigm in conjunction with teaching aids to enhance student learning results, as stated (Sakti et al., 2021) on elasticity and Hooke's law materials at SMAN 1 Sakti, Pidie Regency " There has been a rise in the average learning outcomes of the class applied by the PjBL model assisted by teaching aids by 80.08 and the class applied by the conventional model by 59.15. 2) "The application of PjBL based on simple teaching aids to increase the HOTS of students" The typical HOTS score of pupils has increased from 61.96 to 71.49 (Sambite et al., 2019).

The purpose of the study was to determine if there was an improvement in the pupils' science process abilities using the PjBL model assisted by teaching aids on the work and energy material in class X MAS Syamsuddhuha

METHOD

Quantitative research is the kind that is employed. Because there is a control group, the study design qualifies as a quasi-experimental design because it cannot control the outside factors that influence how the experiment is carried out. The Nonequivalent Control Group is the type of design employed in this investigation. The research was conducted at MAS Syamsuddhuha, located in Cot Murong, Dewantara sub-district, North Aceh district. The research time is in the academic year 2021–2022 on the even semester.

All students of class X were used as the study population. MAS Syamsuddhuha. The samples taken by the researcher used a purposive sampling technique, namely class X IPA 4, which consisted of 21 students (as a class taught by applying the PjBL model assisted by teaching aids), and class X IPA 5, which had 20 students, acting as the control group (as the class that taught without applying the PjBL model assisted by teaching aids). The sample was chosen because of the physics teacher's consideration that the class was considered to have the same abilities.

Two variables are used; the dependent variable is the student's capacity for the scientific process. While the independent variable is the PjBL model assisted by teaching aids on the material of work and energy.

Two data-gathering methods are used in this study, including multiple-choice test questions, as many as 20 questions based on the scientific process skills indicators on the work and energy material, and a non-test, namely the observation sheet scientific process abilities. The indicators measured on the test instrument and observation of students' science process skills (1) Observing or observation (2) Grouping or classifying (3) Interpret or interpretation (4) Forecasting or Prediction (5) Ask Questions (6) Hypothesize (7) Planning the Experiment (8) Using tools or materials (9) Implement the concept (10) Communicate.

The data analysis technique in this study carried out two data analysis tests, namely the pre-test test analysis and hypothesis testing. The pre-analysis test consisted of normality and homogeneity tests between experimental and control group subjects. All data is processed using SPSS 25.0 for windows. The increase based on the N-gain test (Wiyanto, 2008).

RESULT AND DISCUSSION

The results of descriptive statistical analysis using the SPSS For Windows 25.0 application are in Table 1.

Table1 Descriptive statistical analysis results

	Min	Max	Mean	Std. Deviation
Pre-test Experiment	15	60	43.80	12.73
Pretest Control	15	60	34.75	11.41
Posttest Experiment	70	100	81.19	9.73
Posttest Control	50	95	66.00	12.09

The Table 1 demonstrates that the typical pre-test score obtained from students is 43.8, and the post-test average value is 81.19, so there is a difference in the value of 37.39. And the average value of the pre-test obtained by the students is 34.75, and the average value of the post-test is 66, so there is a difference in the value of 31.25. Seen based on the difference between the pre-test and post-test average values scores of the control and experimental classes. Therefore, students in the experimental class have stronger science process skills than those in the control class. Before testing the hypothesis, the normality test can be seen in Table 2.

Table 2 The results of the pre-test and post-test normality tests for the experimental class and the control class

	Class	Shapiro-Wilk		
		Statistic	Df	Sig
Pretest	Experiment	0.935	21	0.175
	Control	0.968	20	0.704
Posttest	Experiment	0.897	21	0.031
	Control	0.941	20	0.251

Based on the Table 2, the experimental class pre-test data has a sig value of 0.175> 0.05. The experimental class pre-test data is normally distributed, and Considering that the control class pre-test data has a sig value of 0.704>0.05, data is normally distributed. And the post-test data of the experimental class has a sig value of 0.031 < 0.05, then the post-test data of The post-test data for the control class have a sig value of 0.251 > 0.05 and the experimental class is not normally distributed, so data of the control class is normally distributed (Sugiyono, 2017).

After performing the normality test, the homogeneity test was carried out along with the homogeneity test results of the pre-test experimental class and control class. The following Table 3 pre-test results of the homogeneity test of the experimental class and the control class.

Table 3 The results of the homogeneity test of the experimental class and the control class

		Lavene Statistic	Df 1	Df 2	Sig
Pre-test	Based on Mean	0.913	1	39	0.345

Based on the Table 3, the homogeneity test value is sig 0.345, meaning that the sig value > 0.05, and the pre-test value is homogeneously distributed. Then test the hypothesis by using the t-test.

Table 4 The outcomes of the pre-hypotheses test for the experimental class and the control class

		T	Df	Sig. (2-tailed)
Pre-test	Equal variances assumed	2.39	39.0	0.022
	Equal variances not assumed	2.40	38.8	0.021

According to the data shown in Table 4, the value of the 2-tailed sigmoid is 0.022 0.05. This demonstrates that before learning, the skills of the students in the experimental class and control classes differed. Regarding both the experimental class's and the control class's post-test hypothesis test results, hypothesis test used in this study was a non-parametric test using SPSS 25 For Windows. When the post-test normality test revealed that the experimental class' post-test data were not normal, the researchers continued their data analysis using a non-parametric test called the Mann-Whitney.

Table 5. Results of a Mann-Whitney test

Statistics Test	
Science Process Skills	
Mann-Whitney U	76.500
Wilcoxon W	286.500
Z	-3.523
Asymp. Signifikan. (2-tailed)	0.000
a. Grouping Variable: Class	

Based on Table 5, it was found that the Asymp value, significant (2-tailed), was 0.000 less than the significant value of 0.05, meaning that H_0 was accepted and H_a was refused. Consequently, it may be said that educational tools aid various project-based learning models (PjBL) to enhance students' scientific method abilities on work and energy materials.

The conclusions of the science process skills observation sheet were used to guide the learning process, which observers observed. The analysis stage is to add the indicators from the scientific method abilities.

Table 5 shows the percentage of science process skills of the students in the experimental class using the PjBL learning model assisted by teaching aids to 21 students. Based on the analysis based on the findings of the observation form on students' science process skills, the highest percentage of classification and grouping indicators with a value of 90%, and the lowest percentage of hypothetical indicators with a value of 80%. The percentage of groups of students considered to have good science process skills is 84.1%. This is because students happily conduct experimental activities using the PjBL model assisted by teaching aids. This is in line with several studies which state that the implementation of PjBL has an effect on science process skills (Nasir et al., 2019; Rusmini et al., 2021; Safaruddin et al., 2020).

The analysis of the increase in the experimental group, which received care through the PjBL model assisted by teaching aids, had a science process skills of students valued at 66%. The control group received PjBL learning model treatment. Without the help of learning media, with a value of 51% with moderate criteria. However, the proportion of N-gain values in the experimental and control classes differs; where the experimental class is 15% higher, the results of the student's overall science process skills are better than the control class. This is because the control class does not use teaching aids, so the students' science process skills are higher in the experimental class (Wiyanto, 2008).

Table 6 Results of scientific method abilities observation sheets

Indicator	Student Score			Amount
	K1	K2	K3	
Observe	80	75	90	81.6%
Classification or Grouping	90	90	90	90%
Interpret or Interpret	85	80	85	83.3%
Prediction	90	75	80	81.6%
Asking question	85	85	85	85%
Hypothesize	80	80	80	80%
Planning an Experiment	80	80	90	83.3%
Using Materials and Tools	75	85	95	85%
Applying the Concept	80	90	90	86.6%
Communicate	85	85	85	85%
Total score	83%	82.5%	87%	84.1%

Based on the results of calculations using the N-Gain test for the experimental class and control class, it is obtained equal to 66%. This is consistent with research findings obtained by Hurnita (2019) in her research entitled "the application of the PjBL model assisted by teaching aids to improve student learning outcomes on the material of Elasticity and Hooke's Law at SMAN 1 Sakti, Pidie Regency". Experiment, the average increased by 0.79, including the high category and in class, the average control increased by 0.65, including the low category.

CONCLUSION

The application of the PjBL model, assisted by the science process skills of students can be enhanced by teaching aids. The experimental class and the control class have different values. The experimental class, which was given treatment in the form of the PjBL model assisted by teaching aids, had science process skills of students valued with a value of 66% and the control class, which was given a treatment of the PjBL learning model without the aid of learning media with a value of 51%. However, the proportion of N-gain values in the experimental and control classes differs; where the experimental class is 15% higher, the overall students' science process skills are more valuable than those in the control group. This proves that applying the PjBL model with teaching aids has increased students' science process skills in work and energy.

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