

The Effect of STEM Approaches (Science, Technology, Engineering, and Mathematics) on Learning Outcomes

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KEYWORDS

Learning Outcomes, STEM (Science, Technology, Engineering, and Mathematics), Conventional Learning.

ABSTRACT

The purpose of this study is to improve the learning outcomes of alternative energy subthemes by using quasi-experimental research methods of two groups of designs at Selaawi State Elementary School. The subjects of this study were students of class III-A and III-B of Selaawi State Elementary School consisting of 53 students. This research was conducted in the even semester of the 2020/2021 academic year. The results showed that there is an influence of STEM (Science, Technology, Engineering, and Mathematics) Approaches on Learning Outcomes of Alternative Energy Subthemes. This can be seen from the average N-Gain value in the experimental class group of 79 with a high category, and the average N-gain value in the control class of 57.77. Thus, the results of testing the hypothesis that H_0 is rejected and H_a is accepted because of $t_{hitung} > t_{tabel}$ which is $9.5202 > 2.00758$. Based on the results of this study, it can be concluded that this study shows that there is a positive influence on the use of STEM approaches.

INTRODUCTION

Education in the 21st century requires schools to be able to create students who are able to compete cognitively, skillfully, and compete technologically. Thus, teachers must be able to carry out a learning process that is able to make students able to compete in the era of globalization. We cannot deny that in the era of globalization with the rapid development of the times, the role of education is very important in preparing students to have good learning outcomes to face competition in the 21st century. Students often know information earlier than their teachers. Therefore, teachers must follow the latest developments both regarding approaches, strategies, methods, or models in the learning process. Especially this process must be carried out in Selaawi State Elementary School.

One of the learning that is relevant to the learning objectives of the 21st century is by learning using a STEM (Science, Technology, Engineering, and Mathematics) approach. Science, Technology, Engineering, and Mathematics or abbreviated as STEM is a popular learning approach at the world level that is effective in the application of Integrative Thematic Learning because it combines four main fields in education, namely science, technology, engineering, and mathematics.

Science, Technology, Engineering and Mathematics or abbreviated as STEM is a popular learning issue at the world level that is effective in applying Integrative Thematic Learning because it combines four main fields in education, namely science, technology, mathematics, and engineering. Torlakson (Sukmana, 2018) stated that the approach of these four aspects is a harmonious match between problems that occur in the real world and also problem-based

learning. So STEM is a learning approach that can be used in the learning process to improve learning outcomes in the 21st century.

In the learning process using a STEM approach, information is formed through collaborative risk-taking and creativity, which means that students use skills and learning processes in science, technology, engineering, and mathematics in thinking and solving problems. By applying the STEM approach in an integrated thematic learning process, it is hoped that it will equip students with the skills and learning outcomes needed by students in facing the competition of the 21st century.

According to (Budi, et al, 2018), learning using a STEM (Science, Technology, Engineering, and Mathematics) approach has an influence on improving students' critical thinking skills.

The 2013 curriculum is a curriculum applied in Indonesia. This curriculum guides students to think critically, creatively, and be able to solve problems with innovation. STEM-based learning is learning that integrates four disciplines, namely Science, Technology, Engineering, and mathematics in one learning that can lead students to innovate in problem solving.

Based on observations at SD Negeri Selaawi it was found that in the learning process in this Alternative Energy Subtheme, teachers still have not found the right approach in the learning process, so that this can affect learning outcomes in the subtheme, especially in this subtheme it is more inclined to the content of Natural Science (Science) lessons.

Learning outcomes in the Alternative Energy Subtheme, both in class A and class B are the lowest, compared to other subthemes, this can be seen from the average score obtained by the majority is still below the Minimum Completeness Criteria (KKM), which is 70 with an achievement of 60% in class A, and 57.14% in class B. This means that learning outcomes in the Alternative Energy Subtheme are still relatively low. This is because teachers have not found the right approach to the learning process in the Alternative Energy Subtheme, and have never used STEM (Science, Technology, Engineering, and Mathematics) based learning so this affects student learning outcomes.

Efforts to activate student participation in this subtheme process require an appropriate learning approach so that students can develop the ability to think critically to find out and find and solve real problems from various experiments conducted, considering that with the right approach and learning model, it is hoped that students can carry out learning activities without feeling forced, because the learning activities carried out are very fun with Involving students to be active in learning which will later have an impact on the learning outcomes obtained by finding concepts that are learned easily through the right approach.

In the learning process using this STEM approach, students need to be given the opportunity to solve various existing problems and experiments, both in groups and independently, students must be used as learning subjects, so that students cannot play an active role in the learning process in this subtheme, because this subtheme contains the context of student life, which requires students to be active in the learning process with Conduct direct investigations through experiments conducted to find the concept of the concept studied.

METHOD

This research was conducted at SDN Selaawi, Bogor Regency. In May 2021 Even Semester, Learning Year 2020/2021. The subjects of the study in class III amounted to 53 students in 2 classes. This type of quantitative research with a research approach is a quasi-design experiment of two groups. There is one class group that is given treatment with the STEM Approach model with the Project Based Learning model, and one class group is not given treatment with the conventional model.

The data collection technique used is a test technique, where in taking the assessment there is an initial test (Pretest) and a final test (Posttest) with 40 multiple-choice questions. That way valid questions are obtained and the process of discriminating power has been carried out, the questions used for research are as many as 25 questions. Before carrying out the learning process, researchers provide an initial test (pretest) with classes that have been determined as experimental classes and control classes, then in the implementation of learning researchers treat

experimental class groups with a STEM Approach with a Project Based Learning model with material that has been compiled in the RPP in accordance with PBL steps and supported by the existence of learning media, After the learning process takes place, there is an evaluation of learning outcomes and researchers give a final test (posttest) with the same questions but randomized.

Furthermore, the implementation to the control class group with a conventional model with the same material content and has been arranged in the RPP with the support of learning media, after the learning process takes place the researcher gives a final test (posttest). That way the data on student learning outcomes is processed and the influence of learning outcomes between the two treatment models can be known.

The stages of an effective STEM-PjBL approach according to Laboy-Rush (Abdi, 2020) are as follows: 1) Reflection brings students into a problem and provides motivation to investigate and solve, 2) Research extracts information from various relevant sources, 3) Discovery bridges between research and application in making a project design, 4) Application tests products / solutions in solving problems, 5) Deliver from a project/solution

The STEM approach also has advantages, namely: 1) Fostering an understanding of the relationship between the principles, concepts, and expertise of a particular discipline, 2) Arousing students' curiosity and activating creative imagination and critical thinking, 3) Helping students to understand and experiment with the scientific process, 4) Encouraging problem-solving collaboration and interdependence in group work, Building active knowledge and memory through independent learning, 6) Develop the relationship between thinking, acting and learning, 7) Develop students' ability to apply the knowledge they have learned.

The shortcomings in the application of the STEM learning model are as follows: 1) It takes a long time to solve problems, 2) Students who are weak in experimentation and information gathering will have difficulties, 3) There is a possibility that learners who are less active in group work, 4) If the topic of each group is different, students may not be able to understand the topic as a whole (Izzani, 2019).

RESULTS AND DISCUSSION

A. Learning Outcomes Data STEM (*Science, Technology, Engineering, and Mathematics*) Approach Alternative Energy Subtheme Experimental Class Using Project Based Learning Model.

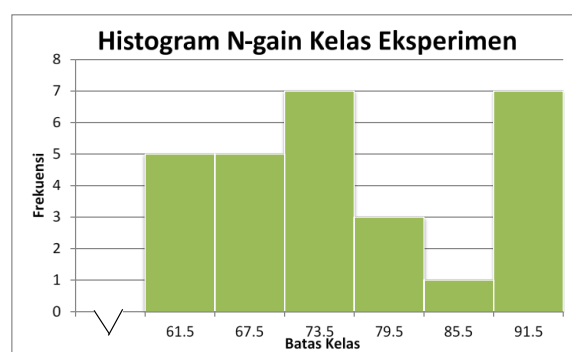


Figure 1. N-Gain histogram graph of Experimental Class Group with STEM (*Science, Technology, Engineering, and Mathematics*) Approach with *Project Based Learning* model.

Based on the data obtained before and after students received treatment with a STEM (Science, Technology, Engineering, and Mathematics) approach to the Alternative Energy Subtheme of the Experimental Class Using the Project Based Learning Model, the N-Gain calculation was carried out so that a minimum score of 62 was obtained, and a maximum score of 92.

Obtaining N-Gain scores in the experimental group or through the STEM (*Science, Technology, Engineering, and Mathematics*) approach learning model with the *Project Based Learning* model, it turned out that 28 students had various *N-Gain* scores. At the class limit of 61.5 - 67.5 there are 5 students, at the class limit of 67.5 - 73.5 there are also 5 students, 7 students who get 73.5 - 79.5, and there is 1 student who gets 85.5 - 91.5, and the last is 7 students get 91.5 - 100.5, it can be concluded for all the highest student scores at the class limit 73.5 - 79.5 and 91.5 - 100.5. So the histogram graph of learning outcomes of the Alternative Energy subtheme using the STEM (*Science, Technology, Engineering, and Mathematics*) approach with the *Project Based Learning* model can be seen in the picture below:

B. Learning Outcomes Data STEM (*Science, Technology, Engineering, and Mathematics*) Approach Alternative Energy Subtheme Experimental Class Using Project Based Learning Model.

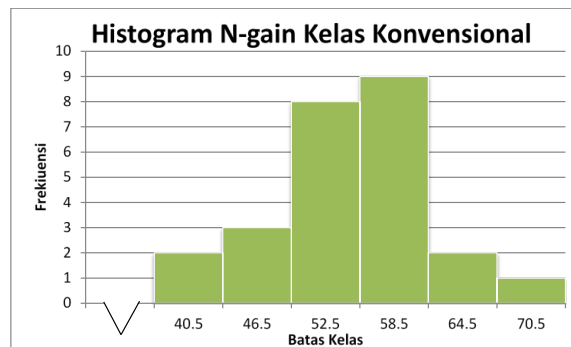


Figure 2. The histogram graph of the N-Gain score of the group (control class) uses a conventional model.

Based on the data obtained before and after students get learning using conventional models, N-Gain calculations are carried out so that a minimum number of values of 42, a maximum value of 75, and an average N-Gain value of 57.77 are obtained. It can be seen in the image below:

C. Differences in Learning Outcomes of Alternative Energy Subthemes Through STEM (*Science, Technology, Engineering, and Mathematics*) Approach Approach with Project Based Learning Model, and Conventional Model

Based on the data of the average pretest score, and the average posttest score and N-gain score obtained by the experimental class group with the STEM (*Science, Technology, Engineering, and Mathematics*) approach with the *Project Based Learning* model and the control class group using the conventional model, there are differences in each class group. These results can be seen in the histogram chart in the figure below:

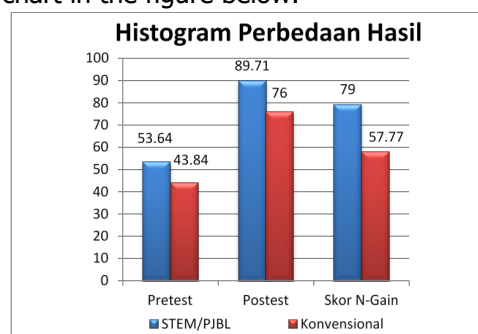


Figure 4. Histogram of average score of learning outcomes of alternative energy subtheme using STEM (*Science, Technology, Engineering, and Mathematics*) approach with *Project Based Learning* model and conventional model.

In the picture above, it can be concluded that the learning outcomes of alternative energy subthemes using the STEM (*Science, Technology, Engineering, and Mathematics*) approach with the *Project Based Learning* model are better than the learning outcomes using conventional models. According to (Muharomah and Dewi, 2017) The results of this STEM learning research affect the learning outcomes of students.

Thenormality test aims to find out whether the distribution data is normal or not. Normality testing was carried out in two groups, namely group A using the *Problem Based Learning* learning model and in group B using the conventional learning model.

Normality testing is carried out using the Liliefors Test, provided that:

$H_0 = L_{count} > L_{table}$, meaning the sample came from an abnormal population.

$H_a = L_{count} < L_{table}$, meaning the sample comes from a normal population

Table 1. Normality Test Results

No	Distribusi kelompok	L_{hitung}	L_{tabel}	Kesimpulan
1	Hasil belajar subtema energi alternatif melalui Pendekatan STEM (<i>Science, Technology, Engineering, and Mathematics</i>) dengan model <i>Project Based Learning</i>	0,0378	0,161	Distribusi normal
2	Hasil belajar subtema energi alternatif kelas kontrol melalui model pembelajaran konvensional	0,04	0,173	Distribusi normal

Based on the normality test using the liliefors test in the experimental class using the STEM (*Science, Technology, Engineering, and Mathematics*) approach with the *Project Based Learning* learning model, a calculated L_{of} (0.0378) was obtained. This figure is compared to the table's L number of (0.161). So the distribution of experimental class data using the *Project Based Learning* learning model is normal.

While the normality test in the control class by applying a conventional model, obtained a calculated L of (0.04). This figure is compared to the table's L number of (0.173). So the distribution of control class data using conventional learning models is normal.

Based on the data above, it can be concluded that the results of the normality test on the learning outcomes of alternative energy subthemes that use the STEM (*Science, Technology, Engineering, and Mathematics*) Approach with the *Project Based Learning* model and those that use conventional learning models are declared to be normally distributed.

Table 2. Test Results of Homogeneity of Instruments Learning Outcomes of Alternative Energy Subtheme

Kelompok kelas	Jumlah sampel	Dk Pembilang/ Dk Penyebut	F_{hitung}	F_{tabel}	Kesimpulan
STEM dan konvensional	53	28/25	1,57	1,95	Homogen

Based on the calculation results in the homogeneity test above, the results of learning the alternative energy subtheme with the numerator $dk\ n1-1 = 28-1 = 27$ (the largest variant), the denominator $dk\ n2-1 = 25-1 = 24$ (the smallest variant) with a significance level = 0.05, the table $f = 1.95$ was obtained with the following test criteria:

If then it is not homogeneous. $F_{hitung} \geq F_{tabel}$

If then homogeneous. $F_{hitung} \leq F_{tabel}$

Since (1.57) (1.95), it can be inferred the variance of both samples from a homogeneous group. That the distribution of variance comes from homogeneous groups. $F_{hitung} \leq F_{tabel}$

CONCLUSION

Based on the results of the study, it can be concluded that there is an influence on the learning outcomes of alternative energy subthemes through the STEM (Science, Technology, Engineering, and Mathematics) approach at SD Negeri Selaawi grade III Even Semester of the 2020/2021 academic year.

There was an influence on the learning outcomes of the alternative energy subtheme between students in the experimental class group getting an average N-gain value of 79, while the average N-gain value in the control class was 57.77. The data can be strengthened by testing the two-way null hypothesis which proves that $t_{hitung} > t_{tabel}$ is $9.5202 > 2.00758$, which means that H_0 is rejected and H_a is accepted.

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