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The Influence of STEM (Science, Technology, Engineering, and Mathematics) Based Learning on Science and Science Learning Outcomes

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Abstract: The teacher has not implemented the learning process using STEM (Science, Technology, Engineering, and Mathematics) optimally in the application of science subjects, and science learning outcomes for class IV elementary schools are generally not optimal. The research was conducted to find knowledge regarding whether there is an impact of using the STEM learning model on science learning outcomes in elementary schools. The type of approach used is quantitative with a research design using a quasi-experiment. Sampling in this study used purposive sampling, and because the population in this study was class IV students consisting of 4 classes, this review sample consisted of 2 classes, namely the control class and the experimental class. The sample for this research consisted of 40 students consisting of 20 students from class IVA and 20 students from class IV B. In this research, the data collection methods used were observation, interviews, and tests. Data analysis techniques use normality, homogeneity, and hypothesis tests, as well as descriptive analysis and test criteria. Based on data analysis of research findings, STEM-based learning has a significant positive impact on the performance of students in class IV science lessons and improving science learning outcomes

Keywords: IPAS; Learning outcomes; STEM

Introduction

Education in Indonesia continues to organize other educational programs, especially the latest development of independent study education programs in public schools. According to Rahmadayanti et al (2022), the independent curriculum education program provides teachers with the ability to adapt and the opportunity to realize quality, or at least it can be done anywhere, anytime, even from any source. There are efforts to build a profile of Pancasila that can provide valuable opportunities for students to learn from a fast-paced environment as a feature of their educational plans, opportunities that are recognized by students, teachers, and schools are a feature of the independent curriculum which means preparing them so they can engage with growing experience. Education in Indonesia cannot be separated from the use of learning methods. Among the learning methods that exist and can be used are STEM learning strategies.

As shown by Mu'Minah et al (2019), STEM learning strategies are learning techniques that combine components of innovation, science, design, and mathematics into a learning experience. He also explained that STEM is something new in the world of education whose aim is to prepare innovative citizens who will bring change to the learning system that is developing in the technological era. Yulaikah et al (2022) stated that the advantages of STEM in learning help students develop their creative attitudes. This STEM learning method can be applied in science lessons.

In science lessons, according to Sunarno (2018), the scope of science and science lessons and science examples can contribute to the creative development of

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students as reliable substitutes in the future to face the modern revolution 4.0. One of the areas that must be dominated is technology and innovation so that STEM-based learning can be applied to science, mathematics, science, technology, innovation, and design illustration lessons, all of which are coordinated into STEM training to help students understand and solve environmental problems by utilizing technology.

Permanasari (2016) This STEM-based learning strategy expects students to be able to solve problems, direct exploration, and differentiate new data, for example how to make an object. Focusing on current realities in education helps participants learn how to overcome a problem. Interesting and innovative STEM education can produce creative students.

Farwati (2021) stated that the advantage of STEM-based learning is that it helps improve learning outcomes, where the benefits mentioned above arouse students' interest and direct students' creative minds imaginatively in educational experiences. When selecting performance strategies, a teacher's ethos can move learners regardless of their success. In addition, broadening motivation can also be utilized. Educators can be relied on for their abilities at the start of the learning cycle and have moral principles that are very important in directing learning.

From the findings of observations of STEM-based learning experiences carried out in grade IV elementary schools. Based on the results of an interview conducted on Friday 11 August 2023 with Mrs. Ernawati, S.Pd. He explained that STEM learning had been implemented in class IV in science subjects which are currently known as IPAS, in this learning he only focused on the science aspect. It can be concluded that the STEM learning experience completed by the teacher was not optimal at the time of implementation.

In STEM learning in elementary schools, according to Zuryanty et al (2020), children are given the opportunity to make a technology-based product or assemble a product that contains a technological element. According to Septantiningtyas, dkk (2021) based on Bruner's learning hypothesis, children must be given the opportunity to carry out practical activities, for example controlling objects or objects (props) with the aim that young children will see basic examples of the objects they see . This movement aims to ensure that the younger generation can find ways to take their own action in overcoming a problem.

In an effort to improve science and science learning, the learning method that can be used is STEM. Mulyani (2019) said "STEM education is a strategy in training where science, technology, design, mathematics are coordinated with an instructive cycle centered on solving problems in real daily life as well as in professional life". The results of research written by Ilmi et al (2021) entitled "The Influence of the Science, Engineering, Technology, Mathematics (STEM) Approach on Student Learning Outcomes in Elementary Schools" show that the STEM approach further develops topical learning outcomes through the most common methods in deal with problems in everyday life.

Referring to this explanation, it encourages researchers to consider additional research on the impact of STEM-based learning on the science and science learning outcomes of class IV elementary schools in the hope that it can help students in learning. The aim is to find out whether STEM-based learning has an impact on the science and science learning outcomes of class IV elementary school students.

Method

The research method uses quantitative methods. (Sugiyono, 2013) quantitative research is a type of statistical analysis using data collection techniques based on statistical analysis tools and hypothesis testing. This type uses a quasi-experimental method. Experimental research is used to be able to see the cause and effect between variables This research was conducted at SDN 167 Pekanbaru on Jl. Muhajirin, West Sidomulyo, Tampan District, Pekanbaru City.

The population of this study was all class IV students at SDN 167 Pekanbaru with a total of 173 people. Meanwhile, the sample was class IV A 20 people, and IV B 20 people, totaling 40 students who were used as research samples. The researchers chose classes IV A and IV B because the learning activities are centered on science aspects only, but learning involving STEM is rarely implemented.

Table 1. Instrument grid of pre-test and post-test questions

Indicator	Cognitive					Psychomotor		Question
	C1	C2	C3	C4	C5	P1	P2	
Identify various energy transformations in everyday life	1,3	2						3
Explain potential energy and what constitutes potential energy	4,5	6	7					5
Identify energy sources		14, 15	8	9	10			3
Explain what is included in kinetic energy (movement)	11,12		13					4
Distinguish the functions of the tools used						16		
Rearranging the range of products displayed							17	

Observations, interviews, and tests are the data collection approaches used, while instrument grids and instrument trials are data collection tools used to modify research variables. Descriptive analysis, analysis requirements testing, and N-Gain data hypothesis testing are the data analysis techniques used.

Result and Discussion

After testing the instrument, the researcher tested the validity of the answers to the questions. The results of the validity test on the pretest and posttest used the SPSS for Windows version 25 tool. The aim was to determine the validity of the questions given. Researchers use the r table as a comparison with the calculated r-value, for r table df = (N-2), the 5% significance level is 0.413. The following are the results of the content validity of the instrument:

Tabel 2. Uji validitas instrumen

r_{count}	r_{table}	Information
0.986	0.413	Valid

The table above shows the results that of all statement items, that is 17 statements, the results show that all statements are declared valid. So, the 17 questions were declared valid and suitable for use to obtain research data.

The next stage after testing the validity of the instrument is measuring the reliability of the data. To determine the reliability of the instrument, the author uses the SPSS program to calculate the reliability of an instrument. To be able to determine the reliability of statement items, testing was carried out using the SPSS 25 computer program with the *Cronbach's Alpha* formula.

Table 3. Reliability Test Results

Variable	*Cronbach's Alpha*	N of Item	Information
STEM-based learning	0. 851	17	Reliability/Good

Summary of reliability tests, Cronbach's Alpha on the pretest and posttest instruments is 0.851, this means that the statements for all questions are good. Where the pretest and posttest question instruments with an alpha value of 0.851 means the instrument is reliable or good. So the question statements on this research variable are good enough to be used as research instruments.

The normality test is carried out next, after the reliability test. The purpose of this test is to find out whether the data collected from the pretest and posttest scores is accurate or not. The researcher calculated the normality test using SPSS. The significance value obtained must be greater than the alpha degree of 5% (significance>0.05) so that the data can be normally distributed.

Table 4. Pretest Normality Test Results

Class	Statistic	Df	Sig.	Statistic	Df	Sig.
Pretest Experimental	.142	20	.200	.964	20	.634
Pretest control	.140	20	.200	.942	20	.264

From the table above, the pretest value for the experimental class is 0.634, while the pretest value for the control class is 0.264. This means that the characteristics of the experimental and control classes are greater than alpha 0.05, so α 0.05 (0.634 > α = 0.05 and 0.264 > α = 0.05) is normally distributed.

Table 5. Posttest Normality Test Results

Class	Statistic	Df	Sig.	Statistic	Df	Sig.
Posttest experimental	.163	20	200*	.932	20	.113
Posttest control	.150	20	200*	.946	20	.323

In accordance with the table above, it is clear that the experimental posttest value is 0.113 and the control class posttest is 0.323, this shows that the two classes have a higher score, comparing alpha 0.05 to α 0.05 (0.113 > α = 0.05 and 0.323 > α = 0.05), both classes have a normal distribution.

Researchers used the SPSS program to test the homogeneity of fluctuations in the two classes after completing the normality test and determined that both classes had a normal distribution.

Table 6. Pretest Homogeneity Test Results

	Statistic	Df1	Df2	Sig.
Based on mean	.250	1	38	.632
Based on Median	.354	1	38	.563
Based on Median and with adjusted df	.354	1	37.015	.563
Based on trim med mean	.269	1	38	.607

The homogeneity test results show a probability value of 0.632 > α = 0.05, so Ho is accepted. This shows that both classes come from homogeneous classes.

Table 7. Posttest Homogeneity Test Results

	Statistic	Df1	Df2	Sig.
Based on mean	2.840	1	38	.100
Based on Median	2.814	1	38	.102
Based on Median and with adjusted df	2.814	1	34.214	.103
Based on trim med mean	2.823	1	38	.101

The homogeneity test shows a significance value of 0.100 > α = 0.05, so Ho is accepted. This shows that the

variance of both classes comes from class homogeneity.

Table 8. Summary of pretest and posttest scores

Criteria	Value				N
	Pretest Control	Pretest Experiment	Posttest Control	Posttest Experimental	(Total)
Average (Mean)	43	50.75	45.9	80,65	
Maximum value	45	47	52	73	
Minimum value	34	45	40	65	40
Standard Deviation	3.435113	3.226127	3.567396	2.539685	
Median	40.5	39	45.5	70	
Modus	43	49	42	65	

Based on this summary, it is known that the average influence of STEM-based learning on science and science learning outcomes for classes IV A and IV B at SDN 167 Pekanbaru was attended by 40 students and previously given pretest questions whose aim was to determine the impact of STEM-based learning. The pretest results for this question obtained a score of 50.75 and the posttest results obtained an average score of 80.65.

From the results shown in the pretest and posttest STEM-based learning questions, it shows that there is a significant difference that the posttest is better than the pretest, but this basic assumption cannot be proven if hypothesis testing and N-Gain have not been carried out. For a clearer picture of the average value of the influence of STEM-based learning on the pretest and posttest, you can see the bar diagram in Figure 1.

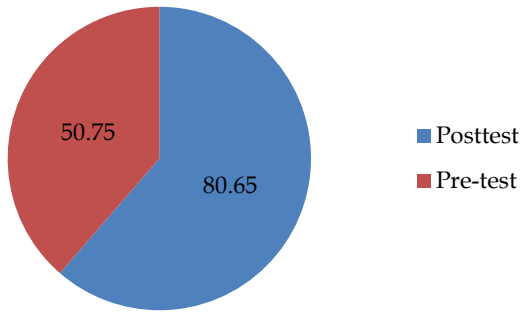

Figure 1. Average value of the influence of STEM-based learning on the pretest and posttest

To determine the feasibility of the impact of STEM learning on science learning outcomes, a hypothesis test was carried out using the SPSS for Windows program. The hypotheses in this research are as follows:

Ha: If the probability is > 0.05, then Ha has an increase or influence on STEM-based learning on science learning outcomes

Ho: If the probability is <0.05, then there is no increase in STEM-based learning on science learning outcomes.

Table 9. Hypothesis Test Results for Experimental Class and Control Class

	F	Sig	t	df	Siig (2-taled)
Equal variances assumed	2.153	151	14.653	38	.000
Equal variances not assumed			14.653	31.333	.000

Based on the hypothesis test table, it shows a significance value of 0.000 < o = 0.05, so Ho is rejected. This shows that there is an influence of STEM-based learning on student learning outcomes. Because in this research the number of samples used is the same, and the normality data is normally distributed, then a t test is carried out, namely:

Table 10. Statistical Test (t Test)

	Paired Differences					T	Df	Sig (2-tailed)
	Mean	Std Deviation	Std error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pretes-Pretest	30.379000	7.85980	1.365333	26.243334	33.367828	14.653	38	.000

Based on the table above, a statistical test is obtained with t = 14.653, and (sig) = 0.000. because pig (sig) <0.05, namely (0.00 <0.05) and the calculated t value determined is greater than the t table of 2.063, then 14,653 > 2.062, thus the researcher can conclude that there is a difference in the influence of STEM-based learning before and after treatment. So, the researcher can conclude that Ho is rejected and Ha is accepted,

meaning that there is an increase in STEM-based learning on the science and science learning outcomes for class IV SDN 167 Pekanbaru.

Table 11. N-Gain Test Results

Group	Average	N-Gain	Result Presentage N-Gain
Pretest	50.75	0.8	80%
Posttest	80.65		
Description category		High	Effective

The findings for calculating the increase in the pretest and posttest for the experimental class are shown in the table above. Because the N-Gain of the experimental class is $0.8 < d \leq 0.8$, the effect is moderate. This shows that STEM-based learning improves student learning outcomes.

Then, to find out the understanding of the influence of STEM-based learning, it can be seen from the N-Gain percentage value, which reaches 80%, which is between 79%-100% in the effective category. This means that STEM-based learning is influential or effective with the results of class IV science and science learning at SDN 167 Pekanbaru.

Based on research on the influence of STEM-based learning on science and science learning outcomes for class IV SDN 167 Pekanbaru, before the research a pretest was carried out and the pretest results obtained a score of 50.75. Next, experiments were carried out with the application of STEM-based learning during three meetings. From that, the next step was to carry out a posttest with the application of STEM-based learning, and the posttest results obtained a score of 80.65.

With an N-gain value of 0.8 which indicates it is within the threshold of G>0.80, the increase in the influence of STEM-based learning is included in the high category. In addition, with a score of 80%, between 79% and 100%, this shows the efficiency of STEM-based learning in improving the learning outcomes of class IV students.

The findings presented here are in line with research entitled "The Impact of STEM (Science, Technology, Engineering, and Mathematics) Based Learning on Student Learning Outcomes on Development Ideas" proposed by Dewi Robiatun Muharomah (2017). By considering these influences, it can be estimated that the use of a STEM learning approach will influence student performance results based on the review that has been carried out.

Then research conducted by Farin Zuhrotun Nisa (2022) with the title "The Impact of STEM (Science, Technology, Engineering, and Mathematics) Learning Relating to Logical Skills and Decision Ability on Reasoning of Class 2023" These test results show that classes with exploration control have very different average test scores. It is reasonable to believe that STEM-based education affects students' critical thinking capacity.

This research is in accordance with previous research, that STEM-based learning influences learning outcomes. It can be concluded that there is a significant increase in STEM-based learning on student learning outcomes.

Conclusion

Based on the research results, it is known that STEM-based learning has a positive impact on the experimental class compared to the control class. This shows that STEM has a great influence on the science and science learning outcomes for class IV SDN 167 Pekanbaru.

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The authors declare no conflict of interest.

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