Attadib: Journal of Elementary Education
Web Jurnal: https://ejournal.uika-bogor.ac.id/index.php/at-tadib/index
p-ISSN: 2614-1760, e-ISSN: 2614-1752

Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

The Impact of PBL-STEM Model on Student Motivation and Achievement in IPAS Learning at Elementary School

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Abstract

This study aims to determine the effect of the STEM-based Problem-Based Learning (PBL) model on students' motivation and learning outcomes in IPAS (Natural and Social Sciences) subjects at SD Negeri Gelang 05. A quasi-experimental method with a pretest-posttest control group design was used. The research sample consisted of two classes of 25 students each, divided into an experimental group and a control group. Instruments included a learning motivation questionnaire, achievement tests, observation sheets, interview guides, and documentation. Data were analyzed using normality tests, homogeneity tests, and independent sample t-tests with the help of SPSS 16.0. The results showed a significant difference between the experimental and control classes in both motivation and learning outcomes. Students in the experimental class scored higher on average in both areas compared to those in the control class. These findings indicate that the STEM-based PBL model is effective in enhancing students' motivation and learning outcomes. It is recommended as an innovative learning approach for IPAS instruction in elementary schools.

Keywords*: Problem-Based Learning; STEM; Learning Motivation; Learning Outcomes; IPAS*

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran Problem-Based Learning (PBL) berbasis STEM terhadap motivasi dan hasil belajar siswa pada mata pelajaran IPAS di SD Negeri Gelang 05. Metode yang digunakan adalah kuasi eksperimen dengan desain pretest-posttest control group. Sampel penelitian terdiri dari dua kelas, masing-masing berjumlah 25 siswa, yang dibagi menjadi kelas eksperimen dan kelas kontrol. Instrumen yang digunakan meliputi angket motivasi belajar, tes hasil belajar, lembar observasi, wawancara, dan dokumentasi. Analisis data dilakukan melalui uji normalitas, homogenitas, dan uji independent sample t-test menggunakan bantuan SPSS 16.0. Hasil penelitian menunjukkan bahwa terdapat perbedaan yang signifikan antara kelas eksperimen dan kelas kontrol baik dalam motivasi maupun hasil belajar. Rata-rata skor motivasi dan hasil belajar siswa di kelas eksperimen lebih tinggi dibandingkan kelas kontrol. Temuan ini menunjukkan bahwa penerapan model PBL berbasis STEM efektif dalam meningkatkan

motivasi dan hasil belajar siswa. Model ini direkomendasikan sebagai pendekatan pembelajaran inovatif untuk pembelajaran IPAS di sekolah dasar.
Kata kunci: Problem-Based Learning; STEM; Motivasi Belajar; Hasil Belajar; IPAS

INTRODUCTION

Natural and Social Sciences (IPAS) is one of the important learning contents in the elementary school curriculum in Indonesia, characterized by its unique approach to explaining natural and social phenomena in a factual and scientific manner. IPAS not only serves as a medium for imparting knowledge about nature and the social environment but also as a tool for fostering logical, critical, and creative thinking among students. Lestari (2024) emphasizes that IPAS incorporates elements of exploration, reasoning, and experimentation as the core of its learning process. In this context, IPAS should be taught using an approach that is not only theoretical but also provides ample space for students to gain direct experience in investigating their surroundings. In accordance with the Regulation of the Minister of National Education of the Republic of Indonesia Number 23 of 2006 concerning Graduate Competency Standards, IPAS learning requires students to understand and use information about the surrounding environment logically, critically, and creatively. This means that the conventional learning approach, which is still one-way or classical in nature, is no longer relevant to be applied dominantly.

The reality on the ground still shows a disparity between curriculum expectations and the reality of IPAS learning in elementary schools. The phenomenon of low student motivation to learn is one of the main indicators of learning problems at various levels of education, particularly at the elementary school level. Taupik and Fitria (2023) reported that many students do not show a high willingness to learn in various subjects, including IPAS. This situation is exacerbated by students' habits of not focusing during the learning process, such as playing with gadgets, drawing in notebooks, or talking to friends while the teacher is explaining (Henrizal, 2020). Maharani and colleagues (2024) even found that low student active participation in class is a major factor in the decline in the quality of material understanding, as learning proceeds monotonously and fails to capture their attention. This situation indicates a lack of intrinsic motivation in students, which is crucial to the success of their learning process. Challenges of education in the digital age are not only about providing technological infrastructure but also about creating learning experiences that can foster students' interest and curiosity. According to a UNESCO report (2023), around 40% of students in developing countries experience prolonged learning loss due to teaching methods that are not adaptive to the changing times. Indonesia, as part of the global community, also faces similar challenges. In addition to motivation challenges, there are also

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p-ISSN: 2614-1760, e-ISSN: 2614-1752

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issues related to student learning outcomes. Ananda (2022) shows that learning in elementary schools in Indonesia is more oriented toward the delivery of theory than exploratory practice. Students are rarely involved in learning activities that are active, investigative, and based on real experiences. However, in IPAS learning, student involvement is key to understanding natural and social concepts comprehensively.

In this context, there is a need to review the teaching approaches used by teachers, especially in IPAS learning. Priyanti and Nurhayati (2023) revealed that the teaching models used by teachers have a significant impact on student learning outcomes. Teaching models that are not varied and innovative often cause students to lose interest in learning. Therefore, it is crucial for teachers to use learning models that can connect lesson materials with real-life experiences and make them relevant to students' daily lives. One approach considered effective in addressing this challenge is problem-based learning (PBL). The PBL model encourages students to actively seek solutions to real-world problems, build knowledge through collaboration, and develop higher-order thinking skills.

PBL is considered to be in line with Dewey's (2013) thinking, which emphasizes that meaningful learning must start from real experiences that can stimulate students' curiosity. Arends (2013) also emphasizes that in PBL, students are not only recipients of information but also active seekers of solutions in the learning process. Research by Resti and colleagues (2021) proves that the application of PBL in learning can increase student participation and understanding of concepts. When students are faced with real problems that are close to their lives, they become more interested in engaging in the process of finding solutions and understanding the material in depth. PBL is also able to create a more collaborative learning atmosphere, as students work in groups and exchange ideas.

Furthermore, the effectiveness of the PBL model can be enhanced through its integration with the STEM (Science, Technology, Engineering, and Mathematics) approach. The STEM approach focuses on solving real-world problems and encourages students to think logically, innovatively, and develop technology- and engineering-based solutions. According to Putra (2023), the integration of PBL and STEM creates a comprehensive, contextual learning process that is oriented toward the development of 21st-century competencies. Students not only learn to understand the material but also develop collaboration skills, critical thinking, creativity, and digital literacy. PBL-STEM learning makes students the main actors in the learning process, not just recipients of information from teachers. This addresses the main challenge in modern education, which requires students to be active, adaptive, and innovative problem solvers.

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However, there is still little research specifically examining the effectiveness of the PBL-STEM model in IPAS learning in the context of elementary schools in rural or semi-urban areas. Most previous studies have been conducted in schools with adequate facilities or located in urban areas. Novita and colleagues' (2022) study at SD Negeri Gelang 05 showed that although students' learning motivation was relatively high, their IPAS learning outcomes were still below the Minimum Competency Criteria (KKM) score. This condition indicates an interesting research gap that warrants further investigation, namely how innovative learning models such as PBL-STEM can mediate the relationship between high learning motivation and low learning outcomes. Additionally, a thorough analysis is needed of the factors influencing low learning outcomes despite students' relatively good learning motivation.

Based on initial observations conducted by researchers at SD Negeri Gelang 05, several factors were found to contribute to the low IPAS learning outcomes. Factors related to teachers include a lack of variety in the use of learning models, a dominance of lecture methods, and low classroom control. Teachers tend to use classical learning models that are unable to stimulate students' enthusiasm for learning. In addition, teachers also do not use contextual approaches or experience-based learning models, causing students to feel bored and unchallenged in the learning process. On the other hand, from the students' perspective, it was found that their low interest in IPAS learning causes them to be easily distracted, slow to understand concepts, and passive during the learning process. Students are also less motivated to participate in the learning process, which they perceive as monotonous and irrelevant to their daily lives.

RESEARCH METHOD

This study uses a quantitative approach with a quasi-experimental research design. The quantitative approach was chosen because this study aims to measure the effect of implementing the STEM-based Problem-Based Learning (PBL) model on student motivation and learning outcomes in an objective, systematic, and structured manner. According to Ramadianti (2023), the quantitative approach allows researchers to analyze and interpret data using statistics. The research design used is a pre-test and post-test control group design, where the researcher compares two groups: the experimental group, which receives treatment in the form of learning using the STEM-based PBL model, and the control group, which does not receive similar treatment. Both groups are tested at the beginning and end of the learning process to determine the effect of the treatment. This design is illustrated in Table1 below:.

Tabel 1. Reseach desain Pre-Test and Post-Test Control Group Design

Class	Pre-Test	Action	Post-Test
Eksperimen	✓	✓	✓
Control	✓	–	✓

This study was conducted at SD Negeri Gelang 05, located at Jl. PTPN Afd XII Karanganom, Desa Gelang, Kecamatan Sumberbaru, Kabupaten Jember. The location was chosen because the school had not yet systematically implemented the STEM-based PBL learning model. Therefore, this school was the ideal location to test the effectiveness of this learning model in improving student motivation and learning outcomes, particularly in IPAS subjects.

The population in this study consists of all fifth-grade students at SD Negeri Gelang 05. According to Suriani & Jailani (2023), the population refers to the entire group of subjects being studied. The total population comprises 50 students, divided into two classes: Class V-A and V-B, each with 25 students, as shown in the table below:

Table 2. Students Total

No	Class	Students total
1	V-A	25
2	V-B	25
	Total	50

The sample used in this study was the entire population, using a saturated sample or total sampling technique, as stated by Subhaktiyasa (2024). Thus, all fifth-grade students at SD Negeri Gelang 05 were used as the research sample, which was then divided into two groups, namely the experimental group and the control group, each consisting of 25 students.\

This study involved two types of variables, namely independent and dependent variables. The independent variable in this study was the STEM-based Problem-Based Learning (PBL) model. This model integrates the syntax of PBL learning with the STEM approach, which includes problem orientation, student organization, investigation guidance, work development and presentation, and problem-solving analysis and evaluation.

Meanwhile, the dependent variables consist of two aspects. First, learning motivation, defined as internal or external drives that encourage students to learn, understand the

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Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

material, and achieve academic goals. Indicators of learning motivation include the desire to succeed, motivation to learn, hopes and aspirations, appreciation for learning, interest in learning activities, and a conducive learning environment. Second, learning outcomes, which refer to students' achievements in cognitive aspects (C1 to C6), measured through pre- and post-treatment knowledge tests.

The data sources in this study consist of primary and secondary data. Primary data were obtained directly through the implementation of pre-tests and post-tests of learning motivation and student learning outcomes. Meanwhile, secondary data included learning observation results, interviews with teachers to explore previous learning problems, and documentation related to the implementation of the STEM-based PBL model in the classroom.

This study follows the quantitative procedure as described by Sugiyono (2021), with the following steps: (1) identifying the research problem based on field phenomena; (2) identifying and formulating the problem; (3) setting research objectives and hypotheses based on relevant theory; (4) developing research indicators and variables; (5) determining the population and sample as well as data collection techniques; (6) developing and testing instruments; (7) collecting data; (8) analyzing data; and (9) compiling research reports.

The hypotheses proposed in this study are:

H_{01}: There is no effect of implementing the STEM-based PBL model on student learning motivation.

H_{a1}: There is an effect of implementing the STEM-based PBL model on student learning motivation.

H_{02}: There is no effect of implementing the STEM-based PBL model on student learning outcomes.

H_{a2}: There is an effect of implementing the STEM-based PBL model on student learning outcomes.

The instruments used in this study consisted of five types. First, a learning motivation questionnaire, consisting of 30 statements with a Likert scale (1–4) covering indicators of desire to succeed, learning motivation, hopes and aspirations, appreciation, interesting activities, and a conducive learning environment. Second, a learning achievement test designed to measure students' cognitive achievements based on Bloom's taxonomy from C1 to C6. Third, a learning observation sheet, used to observe the implementation of the STEM-based PBL model during the learning process. Fourth, an interview guide to gather information from teachers about the learning context. Fifth, a documentation sheet, used to collect supporting data such as photos, grades, and learning records at SD Negeri Gelang 05.

Data analysis was conducted in several stages. First, data from the motivation questionnaire was analyzed using the following formula:

Score = (Total Answer Score)/(Maximum Score) × 100%

Second, student learning outcomes were calculated using the following formula:

Score = (Number of Correct Answers)/(Maximum Score) × 100%

After that, a prerequisite analysis test was conducted, namely a normality test to ensure that the data was normally distributed, and a homogeneity test to determine the similarity of variance between the experimental and control classes. Then, a hypothesis test was conducted using a t-test with the help of SPSS version 16.0 software. This test was used because the data was on an interval scale and the population variance was not known with certainty.

Through this series of procedures and analytical techniques, it is hoped that the research will provide valid and reliable results in addressing the research questions and testing the effect of the STEM-based PBL model on student motivation and learning outcomes in the IPAS subject in Grade V of SD Negeri Gelang 05.

RESULT AND DISCUSSION

RESULT

A. Learning Motivation

Learning motivation was assessed over two meetings. The learning process in class V A, as the experimental class, was carried out using the Problem-Based Learning (PBL) model based on STEM. Meanwhile, class V B served as the control class and did not receive the treatment. The following table presents the recapitulation of the learning motivation analysis scores.

Table 3. Recapitulation of Students' Learning Motivation Scores in the Experimental and Control Classes

	Experimental Class (V A)	**Control Class (V B)**
Number of Students	25	25
Highest Score	48	48
Lowest Score	47	46

Attadib: Journal of Elementary Education
Web Jurnal: https://ejournal.uika-bogor.ac.id/index.php/at-tadib/index
p-ISSN: 2614-1760, e-ISSN: 2614-1752

Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

Mean Score	47.56	46.64
Standard Deviation	0.507	0.637

Based on Table 3, it can be seen that the use of the Problem-Based Learning model based on STEM in the experimental class (V A) resulted in a higher average score compared to the control class (V B). The experimental class scored an average of 47.56, while the control class scored 46.64. Based on this average analysis of learning motivation, a normality test was then conducted.

B. Normality Test

The normality test was conducted to determine whether the data distribution is normal or not. This test is crucial as a prerequisite for using parametric statistical analysis, which requires the data to be normally distributed. The normality test was carried out using the Kolmogorov-Smirnov method because the sample size exceeded 50. In this study, the normality test was applied to the learning motivation scores in both the experimental and control classes.

Table 4.
Results of the Normality Test on Students' Learning Motivation Data

Group	Test Type	Statistic	df	Sig.	Statistic	df	Sig.
	Kolmogorov-Smirnov						
Experimental		0.134	25	0.2	0.965	25	0.442
Control		0.121	25	0.2	0.957	25	0.298
	Lilliefors Significance Correction						

The normality test results in Table 4.2 show that the significance values are greater than the alpha value of 0.05: for the experimental class (0.200 > 0.05 and 0.442 > 0.05), and for the control class (0.200 > 0.05 and 0.298 > 0.05). This indicates that the students' learning motivation data is normally distributed, allowing for further analysis using parametric statistical methods, specifically the Independent Sample T-test.

C. Homogeneity Test

The homogeneity test was conducted to determine whether the variances of the learning motivation data from the experimental and control classes are equal.

Equal variances indicate that before the treatment, the initial condition of the students in both classes was statistically similar in terms of learning motivation.

Table 5. Homogeneity Test Results

Test Type	Levene Statistic	df1	df2	Sig.
Based on Mean	0.783	1	48	0.381
Based on Median	0.805	1	48	0.374
Based on Median and with adjusted df	0.805	1	47.2	0.37
Based on Trimmed Mean	0.782	1	48	0.381

D. Independent Sample T-Test

The data obtained from the observation assessments of both samples were then analyzed to determine whether there was a significant difference in the mean scores between the two groups. The results of the Independent Sample T-Test on students' learning outcomes are presented in the following table:

Table 6.
Summary of Students' Learning Motivation in Control and Experimental Classes Using Independent Sample T-Test

Levene's Test for Equality of Variances	t-test for Equality of Means
F: 0.32, Sig.: .577	**t**: 5.692, **df**: 48
	Sig. (2-tailed): 0.000
	Mean Difference: 0.920
	Std. Error Difference: 0.162
	95% Confidence Interval of the Difference: [0.595, 1.245]

Based on Table 4.4, descriptive data on students' learning outcomes in the two groups—experimental and control classes—were obtained. The average learning outcome score in the experimental class was 77.30 with a standard deviation of 8.10 and a standard error of the mean of 1.62. Meanwhile, the control class had an average score of 70.43, with a standard deviation of 7.37 and a standard error of the mean of 1.47. This data

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p-ISSN: 2614-1760, e-ISSN: 2614-1752

Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

indicates that the average learning outcome of students in the experimental class was higher than that of the control class.

To determine whether the difference in mean learning outcomes was statistically significant, an Independent Sample T-Test was conducted, as shown in Table 4.4. The Levene's Test for equality of variances showed an F value of 0.32 with a significance level of 0.577, indicating that the assumption of homogeneity of variances was met (since the sig. value > 0.05).

Furthermore, the Independent Sample T-Test assuming equal variances indicated that the t-value = 3.22, with df = 48, and a significance value (2-tailed) = 0.022. Since the significance value is less than 0.05, it can be concluded that there is a statistically significant difference between the learning outcomes of students in the experimental and control classes.

The mean difference between the two groups was 6.87, with a 95% confidence interval ranging from a lower bound of 2.58 to an upper bound of 11.16. This indicates that the special treatment given to the experimental class had a significant impact on improving students' learning outcomes compared to the control class.

E. Learning Outcomes

The analysis of students' learning outcomes was conducted over two meetings. Learning activities in class V A (the experimental class) were conducted using the Problem-Based Learning model based on STEM. In contrast, class V B (the control class) received no such treatment. The table below summarizes the analysis results of students' learning outcomes.

Table 7.
Recapitulation of Students' Learning Outcomes in Experimental and Control Classes

	Experimental Class (V A)	Control Class (V B)
Number of Students	25	25
Highest Score	95.2	92.8
Lowest Score	63.2	60.8
Average Score	77.39	70.43
Standard Deviation	8.10	7.37

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Based on Table 4.5, it is evident that the application of the Problem-Based Learning model based on STEM in the experimental class (V A) resulted in a higher average score compared to the control class (V B), with an average score of 77.39 in the experimental class versus 70.43 in the control class. Based on these average scores, a diagram can be created to visually represent the learning outcomes, as shown in Figure 4.5.

F. Normality Test

The normality test aims to determine whether the data are normally distributed. This test is essential as a prerequisite for conducting parametric statistical analysis, which requires normally distributed data. The Kolmogorov-Smirnov method was used in this study since the sample size exceeds 50. The normality test was conducted on the students' learning outcome data from both the experimental and control classes.

Table 8. Normality Test Results of Students' Learning Outcome Data

Class	**Kolmogorov–Smirnov**			**Shapiro–Wilk**		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental	0.112	25	.200	0.960	25	.384
Control	0.123	25	.200	0.952	25	.262

Lilliefors Significance Correction

The normality test results in Table 4.6 show that the significance values are greater than the alpha level (0.05): for the experimental class (0.200 > 0.05 and 0.384 > 0.05) and for the control class (0.200 > 0.05 and 0.262 > 0.05). This indicates that the students' learning outcome data are normally distributed. Therefore, parametric testing using the Independent Sample T-Test can be conducted.

Homogeneity Test

The homogeneity test aims to determine whether the variances of students' learning outcomes in the experimental and control classes are equal. Homogeneous variances indicate that the initial conditions of students in both classes were equivalent in terms of learning outcomes prior to the treatment.

Table 9. Test of Homogeneity of Variance.

	Levene Statistic	**df1**	**df2**	**Sig.**
Based on Mean	0.315	1	48	.577
Based on Median	0.281	1	48	.599
Based on Median and with adjusted df	0.281	1	46.724	.599
Based on Trimmed Mean	0.313	1	60	.579

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Web Jurnal: https://ejournal.uika-bogor.ac.id/index.php/at-tadib/index
p-ISSN: 2614-1760, e-ISSN: 2614-1752

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The result of the homogeneity test using Levene's Test shows a significance value of 0.577, which is greater than 0.05. This indicates that both groups have homogeneous variances, thus further statistical analysis using parametric tests can be performed.

Independent Sample T-test

The data obtained from the observation assessments of both samples were then analyzed to determine whether there is a difference in the mean scores between the two groups. The results of the independent sample t-test on students' learning outcomes are presented in the following table:

Table 10.
Summary of Learning Outcomes in the Control and Experimental Classes Using Independent Sample T-test

	Levene's Test for Equality of Variances	**t-test for Equality of Means**
	F	Sig.
Learning Outcomes	Equal variances assumed	0.783
	Equal variances not assumed	

Table 11.
Group Statistics – Independent Sample T-test of Student Learning Outcomes

Class	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Experimental	25	77.30	8.10	1.62
Control	25	70.43	7.37	1.47

Based on Table 4.9, descriptive data on students' learning outcomes in the two groups experimental and control were obtained. The average learning outcome in the experimental class was 77.30 with a standard deviation of 8.10 and a standard error of 1.62. Meanwhile, the control class had an average score of 70.43, with a standard deviation of 7.37 and a standard error of 1.47. These data indicate that on average, the students in the experimental class outperformed those in the control class.

To determine whether this difference in mean scores is statistically significant, an Independent Sample T-test was conducted, as shown in Table 4.9. The Levene's test for

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p-ISSN: 2614-1760, e-ISSN: 2614-1752

Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

homogeneity of variances shows an F value of 0.32 with a significance level of 0.577, indicating that the assumption of equal variances is met (since sig > 0.05).

Furthermore, the Independent Sample T-test assuming equal variances showed a t-value of 3.22 with a degree of freedom (df) of 48 and a significance (2-tailed) value of 0.022. Since the significance value is less than 0.05, it can be concluded that there is a statistically significant difference between the learning outcomes of students in the experimental and control classes.

The mean difference between the two groups is 6.87, with a 95% confidence interval ranging from a lower bound of 2.58 to an upper bound of 11.16. This indicates that the specific treatment applied in the experimental class had a significant impact on improving students' learning outcomes compared to the control class.

DISCUSSION

Based on the results of data analysis, it was found that there were significant differences in learning outcomes between students in the experimental class and students in the control class. The results of the homogeneity test using Levene's Test show that the significance value of 0.577 is greater than 0.05, which indicates that the variance between the two groups is homogeneous. Thus, the assumption to conduct the Independent Sample T-test test has been met. Furthermore, the Independent Sample T-test test results show a significance value of 0.022 ($p < 0.05$), which means that there is a significant difference between the average student learning outcomes in the experimental class (M = 77.30) and the control class (M = 70.43). This average difference of 6.87 points supports that the special treatment applied in the experimental class had a real impact on improving student learning outcomes.

This finding is in line with various previous studies that confirm the effectiveness of innovative learning models in improving student learning outcomes. For example, research by Nurhasanah & Sobandi (2021) found that the application of digital-based interactive media was able to significantly increase student participation and concept understanding, which in turn had a positive impact on learning outcomes. This study used a similar approach in the context of science lessons and showed that when students were given the opportunity to learn with interesting and participatory methods, their learning outcomes improved.

Study by Wulandari, Rofiah, & Anggraeni (2020) on the use of Canva-based visual learning media showed a significant improvement in primary school students' learning outcomes. In the study, interactive visual media used in the learning process was able to create a more enjoyable learning atmosphere, stimulate student curiosity, and strengthen understanding of learning concepts. This research is relevant to the context of the experimental class in this study which received treatment in the form of a more innovative and interactive learning approach.

Furthermore, research by Rahmawati & Widodo (2020) using a project-based learning model also found a significant increase in learning outcomes compared to conventional learning. In the model, students are involved in learning activities that integrate knowledge and skills in a real context, which strongly supports the development of critical thinking and problem solving skills. The results of this study reinforce that learning models that place students as active subjects in the learning process, will be more effective in improving their learning outcomes.

Meanwhile, in a study conducted by Handayani (2019), a problem-based learning model was applied to improve the critical thinking skills of elementary school students. The results showed a significant increase in concept understanding and student learning outcomes. The study showed that students who learn with a problem-based approach tend to be more active, reflective, and have a deeper understanding of the subject matter, because they are trained to identify and solve problems independently or in groups.

In terms of theory, the results of this study are also consistent with constructivistic learning theory developed by Jean Piaget and Lev Vygotsky. Piaget stated that children construct knowledge through a process of assimilation and accommodation based on their concrete experiences. While Vygotsky emphasized the importance of social interaction and the role of language in children's cognitive development. In the learning context implemented in the experimental class, students are involved in problem-based learning activities that encourage discussion, collaboration and exploration, which are important elements in social constructivistic theory. This allows students to develop their knowledge actively and independently in a supportive environment.

Research by Yuliana & Santoso (2022) supports these findings by showing that the use of constructivist approaches in science learning in elementary schools can significantly improve learning outcomes. The researchers concluded that when students are given the opportunity to actively explore the material through group discussions and problem solving, they are able to build a deeper and lasting understanding of the material learned.

In addition, in an experimental study conducted by Sari and Prasetyo (2021), it was found that the implementation of active learning strategies based on digital technology can improve students' learning motivation and academic achievement. They pointed out that an approach involving interactive digital media provides a more interesting and challenging learning experience.

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Web Jurnal: https://ejournal.uika-bogor.ac.id/index.php/at-tadib/index
p-ISSN: 2614-1760, e-ISSN: 2614-1752
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The findings in this study are also in line with previous research by Fitriyani and Fadillah (2021) who evaluated the effect of application-based learning media on student learning outcomes. The results showed that students who learned using app-based digital media showed a significant improvement in their academic achievement compared to students who learned using conventional methods. This shows that technology, when effectively utilized in learning, can strengthen the learning process and help students achieve better results.

The results of this study can also be related to the theory of learning motivation according to Keller's (1987) ARCS (Attention, Relevance, Confidence, Satisfaction) theory. In the experimental class, the learning strategy used allowed students to get attention through interesting and challenging activities; relevance because the material was related to real life; confidence through activities that gave room for gradual success; and satisfaction because good learning results could be achieved. These four components support students' intrinsic motivation which has a direct impact on improving learning outcomes.

In this context, the use of the right learning approach proved to have a significant positive impact on student learning outcomes. The experimental class that received the innovative treatment obtained higher results than the control class that used conventional methods. This shows that learning strategies designed by taking into account students' needs, learning styles, and active involvement in the learning process will be much more effective in improving learning outcomes than the lecture method or passive assignment.

This finding is also in line with the results of research by Sukardi, Lestari, and Widyawati (2020), who examined the effect of inquiry-based learning models on the learning outcomes of elementary school students. In his research, it was found that students who learned through inquiry had better learning outcomes, because they were encouraged to discover concepts through direct experience and active thinking processes. This shows that when students are cognitively and affectively active in learning, their learning outcomes improve.

This research also provides important implications for teachers in developing learning tools. Teachers are required to be more creative and innovative in designing learning that is oriented towards developing 21st century skills, such as critical thinking, collaboration, creativity, and communication. Problem-based learning strategies, projects, and digital technology are effective approaches to accommodate these demands.

Thus, based on the results of research and review of various previous studies, it can be concluded that the use of innovative learning strategies that involve students actively in the learning process is very influential in improving learning outcomes. This shows the

attadib
Journal of Elementary Education
Attadib: Journal of Elementary Education
Web Jurnal: https://ejournal.uika-bogor.ac.id/index.php/at-tadib/index
p-ISSN: 2614-1760, e-ISSN: 2614-1752
Universitas Ibn Khaldun Bogor
Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

importance of transforming learning in primary schools that no longer only focuses on passive cognitive achievement, but also develops students' potential as a whole through contextual, collaborative and problem-solving-based approaches.

The results of this study make an important contribution to the development of learning in primary schools, especially in learning IPAS or similar subjects. The use of strategies that encourage active student involvement, the use of relevant digital media, and the application of problem-based learning models have been empirically proven to significantly improve student learning outcomes. This is expected to be a consideration for educators and policy makers in developing curriculum and designing learning strategies that are more effective and oriented towards the development of sustainable student learning skills.

CONCLUSION

The results showed that the application of the STEM-based Problem-Based Learning (PBL) learning model significantly improved students' motivation and learning outcomes in IPAS subjects at SD Negeri Gelang 05. Students who took part in learning with the PBL-STEM model showed active involvement, high interest in learning, and better cognitive achievement compared to students who took part in conventional learning. This finding indicates that the PBL-STEM model is effective in creating learning that is contextual, collaborative, and relevant to students' daily lives, so that it can encourage the achievement of 21st century competencies. Therefore, the use of PBL-STEM model is recommended as an alternative innovative learning strategy in improving the quality of IPAS learning in elementary schools.

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p-ISSN: 2614-1760, e-ISSN: 2614-1752

Edisi : Vol. 9, No. 2, Juni/2025, hlm. 338-354

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