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THE EFFECT OF THE PROJECT-BASED LEARNING MODEL WITH A STEAM APPROACH ON STUDENTS' LEARNING INTEREST AND MATHEMATICS LEARNING OUTCOMES IN GRADE VII

Grace Aprilin Latersia Br Trg*, Mangaratua Marianus Simanjorang
Universitas Negeri Medan, Indonesia
Email: gracetrgn25@gmail.com

ABSTRACT

This study aims to determine the effect of the Project-Based Learning (PjBL) model with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach on students' learning interest and mathematics learning outcomes in Grade VII at State Junior High School (SMP Negeri) 1 Pancur Batu. This research employed a quantitative approach using a quasi-experimental method with a pretest-posttest control group design. The sampling technique used was cluster sampling, with two classes selected as samples: Class VII-2 as the experimental class, which received treatment using the PjBL model with the STEAM approach, and Class VII-1 as the control class, which was taught using a conventional learning model. The instruments used were a learning interest questionnaire and a mathematics learning outcomes test. The data analysis using an independent sample t-test showed a significant difference between students' learning interest and learning outcomes in the experimental and control classes. The t-test significance value for learning interest was 0.013 < 0.05, and for learning outcomes was 0.001 < 0.05. Thus, it can be concluded that the Project-BasedProject-Based Learning model with the STEAM approach has a significant effect on improving learning interest and mathematics learning outcomes of Grade VII students.

Keywords: Project-Based Learning, STEAM approach, learning interest, learning outcomes, mathematics.

*** Corresponding Author Email:** gracetrgn25@gmail.com

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INTRODUCTION

Mathematics is a core subject taught at every level of education, as stated in Permendiknas No. 22 of 2006, which emphasizes its role in equipping students with logical, critical, analytical, systematic, and creative thinking, as well as collaborative skills. Mathematics plays an essential role in developing reasoning and problem solving abilities that are applicable in daily life (Maesari et al., 2020). Beyond being a compulsory subject, mathematics is vital for meeting everyday needs, making it inseparable from human activities.

However, despite its importance, mathematics is often perceived by students as difficult, abstract, and uninteresting. Many show boredom, fear, or anxiety toward the subject, largely due to limited understanding of basic concepts, the large number of formulas

to be memorized, and teaching methods that emphasize content delivery rather than comprehension (Wayan Sunita et al., 2019; B. A. Lestari et al., 2023). This perception lowers students' interest in learning and negatively impacts their academic achievement.

Learning interest is a crucial psychological factor reflected in enthusiasm, curiosity, and attention during lessons (Baringbing & Abi, 2022). Interest does not arise spontaneously but develops through meaningful learning experiences. As students gain more knowledge, even those who initially dislike a subject may begin to show increased interest and motivation to study diligently (Kurniasari et al., 2021). Students with high interest participate actively and achieve better results, while those with low interest are often disengaged, less motivated, and perform poorly (Zahra et al., 2023). On the other hand, when students learn with genuine interest and attention, they tend to achieve better results. Without interest in the material presented by the teacher, the likelihood of enthusiastic learning and satisfactory academic performance is significantly reduced.

Learning outcomes reflect students' abilities after participating in the instructional process at school and serve as one of the key indicators of educational success, typically expressed through grades or scores. Learning outcomes are considered achieved when students demonstrate the expected development and behavioral improvements aligned with the instructional goals. Therefore, learning outcomes function as an indicator of a student's engagement and performance in the learning process. The higher the learning outcomes, the more effective the instructional process is deemed to be. Conversely, poor student performance may suggest that the learning process was ineffective or even failed (Yandi et al., 2023). Thus, both interest and achievement are closely linked and influenced by the instructional model applied in class.

In practice, many classrooms still rely on conventional, lecture based models where the teacher dominates and students passively receive information. Such approaches rarely connect content with real life contexts, leading to low motivation and unsatisfactory outcomes. At SMP Negeri 1 Pancur Batu, interviews and observations revealed that Grade VII students' interest in mathematics is relatively low, reflected in their disengagement during lessons and average scores below the Minimum Mastery Criteria (KKTP) shows that in class VII-2, only 13 students achieved mastery, while 17 did not. This indicates the ineffectiveness of conventional methods in fostering interest and achievement.

Table 1. Student Completion in Mathematics Subject Based on Math Exam Score

Class	KKTP	Description	Number of Students
VII - 2	≥ 72	Completed	13
	< 72	Not Completed	17
Total number of students			30

(Source: Seventh-grade mathematics teacher at SMPN 1 Pancur Batu)

The teacher further explained that the mathematics instruction in Grade VII has primarily employed a conventional teaching model. In practice, this means that the teacher relies heavily on lecture based methods, where the teacher assumes a dominant role as the transmitter of information, while students act as passive recipients. Within this conventional instructional approach, teacher activity greatly outweighs student involvement. Moreover, the content delivery is rarely connected to students' real life experiences, which diminishes the meaningfulness of learning. Students are generally expected to listen, take notes, and memorize information, resulting in limited engagement. Consequently, this passive environment negatively affects both students' motivation and their academic performance in mathematics.

To foster students' interest and improve learning outcomes, it is essential to select an instructional model that aligns with the specific context of the classroom and the characteristics of the learners. This alignment ensures that students are more engaged and willing to participate actively during lessons. Teachers should consider adopting learner centered teaching models that encourage students to think creatively and participate actively especially in mathematics classes. One promising approach to address the aforementioned issues is the implementation of the Project-Based Learning (PjBL) model.

Project-Based Learning (PjBL) is an innovative, student centered instructional model in which teachers act as facilitators and motivators, while students are provided with the autonomy to construct their own understanding through active learning processes (Novitasari, 2023). This model engages learners in real-world projects or complex tasks that require problem solving and the practical application of knowledge (Amelia & Aisya, 2021). PjBL provides meaningful learning experiences that improve conceptual understanding and performance (Ruhul Jihadah Gaffar, M. Juaini, 2023). When integrated with the STEAM approach which combines Science, Technology, Engineering, Arts, and Mathematics this model promotes creativity, critical thinking, and interdisciplinary problem solving while connecting learning to real life contexts.

The STEAM approach aims to develop creative, critical, systematic, and logical thinking. In this regard, it can serve as an effective strategy to address students' passive attitudes during mathematics learning particularly when conventional teaching methods are applied. Activities carried out throughout the learning process help foster students' interest, which in turn can lead to improved academic achievement. Integrating STEAM into mathematics instruction enables students to better understand the direct relationship between mathematical concepts and their practical applications in everyday life, as well as the role mathematics plays in the advancement of science, art, and technology.

Therefore, the Project-Based Learning model combined with the STEAM approach does not solely focus on content mastery but also emphasizes the development of critical thinking, creativity, collaboration, and communication skills. Applying the STEAM approach requires students to actively participate and work collaboratively in teams. This level of engagement is expected to increase students' motivation and interest in learning. Higher levels of interest and motivation among students can ultimately contribute to improved learning outcomes (D. M. Putri et al., 2023).

Studies show that PjBL positively influences interest and achievement, though most do not integrate STEAM or focus on both variables simultaneously. Research by Wifa Dauly Kaffah et al. (2023) confirmed the effectiveness of STEAM-based PjBL on cognitive outcomes in biology, while Kikis Megowanto (2023) found positive results of PjBL STEM in chemistry. Similarly, Wayan Sunita et al. (2019) demonstrated the benefits of PjBL in mathematics, though without the STEAM framework. These findings suggest the potential of STEAM-based PjBL to create meaningful, contextual, and creative learning in mathematics, yet studies in this area remain limited.

Various studies have demonstrated that the Project-Based Learning (PjBL) model is effective in enhancing both students' academic achievement and learning interest. However, few studies have integrated PjBL with STEAM in mathematics at the junior high school level while simultaneously examining both learning interest and achievement.". In fact, the STEAM approach holds significant potential to create meaningful, creative, and contextual learning experiences, especially in mathematics education. Moreover, research exploring the influence of STEAM based PjBL on both learning interest and academic achievement remains very limited. Most existing studies tend to focus on only one aspect, despite the fact that these two components are closely interrelated.

Therefore, this research seeks to examine the effect of the Project-Based Learning model with the STEAM approach on students' interest and mathematics learning outcomes in Grade VII. This study is expected to contribute to a deeper understanding of how STEAM based PjBL can enhance both motivation and achievement in mathematics education.

METHOD

This study was conducted at SMP Negeri 1 Pancur Batu, Deli Serdang Regency, during the even semester of the 2024/2025 academic year. The research employed a quantitative approach with a quasi experimental design, specifically the Pretest-Posttest Control Group Design. Two groups were involved, the experimental class (VII-2, 30 students) taught using the Project-Based Learning (PjBL) model with a STEAM approach, and the control class (VII-1, 30 students) taught using conventional learning.

The population consisted of all Grade VII students, while the sample was selected using cluster random sampling. The independent variable was the PjBL model with a STEAM approach, while the dependent variables were students' learning interest and mathematics learning outcomes. Data were collected through observation, interviews, questionnaires, and tests. The questionnaire, developed using four indicators (enjoyment, curiosity, attention, engagement), was administered before and after treatment to measure learning interest. The mathematics achievement test, consisting of multiple choice questions, was given as pretest and posttest to assess learning outcomes.

The instruments used in this study consisted of a learning interest questionnaire and a mathematics test. The research instruments were first tested to examine their quality. The validity test was conducted using the Pearson Product Moment correlation and the reliability test was analyzed using Cronbach's Alpha coefficient. In addition, an analysis of the difficulty index and the discrimination index of the test items was also carried out to ensure the quality of the mathematics achievement test.

For data analysis, prerequisite tests were conducted, including the normality test (Shapiro-Wilk) and homogeneity test (F-test). The hypotheses were tested using the Independent Samples t-Test at a 5% significance level ($\alpha = 0.05$). The analysis aimed to determine whether the PjBL model with a STEAM approach had a significant effect on students' learning interest and mathematics learning outcomes compared to conventional teaching.

RESULT

The data collected consisted of students' learning interest scores and mathematics achievement scores, both before and after the implementation of the treatment. The experimental group was taught using the Project-Based Learning model with STEAM approach**,** while the control group received instruction through conventional teaching. The results of the descriptive statistical summary of students' learning interest and mathematics achievement in both the experimental and control groups are presented in the table below.

Based on the comparison of the data above, it can be seen that the mean scores and the distribution of the pre-test results for the learning interest questionnaire in both classes do not differ significantly. This indicates that prior to the treatment, the students' learning interest in both classes was relatively equal or comparable, making them suitable to be used as comparison groups in this study.

Table 2. Descriptive Statistics Summary of Students' Mathematics Learning Interest Scores

Statistical Data	Experimental Class		Control Class	
	Pre-test Questionnaire	Post-test Questionnaire	Pre-test Questionnaire	Post-test Questionnaire

Average	46,63	52,53	47,57	48,73
Median	45	51,50	46,50	48
Variance	30,792	31,085	37,978	34,478
Standard Deviation	5,549	5,575	6,163	5,872
Minimum Score	39	44	39	40
Maximum Score	61	65	62	63
Range	22	21	23	23

Table 3. Descriptive Statistics Summary of Student' Math Learning Outcome Test Scores

Statistical Data	Experimental Class		Control Class	
	Pre-test	Post-test	Pre-test	Post-test
Mean	28	77,83	27,33	69,67
Median	30	80	27,5	70
Variance	59,655	64,971	71,954	94,713
Standard Devitation	7,724	8,060	8,483	9,732
Minimum Score	15	60	10	50
Maximum Score	40	90	40	85
Range	25	30	30	35

Based on the descriptive table of learning interests above, it can be observed that the students' initial abilities in both classes were relatively comparable, as indicated by the similar mean scores and distribution of the pre-test results. This suggests that prior to the implementation of the treatment, students in both the experimental and control classes had approximately the same level of initial understanding, making them fairly comparable groups for evaluating the effects of the instructional model applied in the subsequent stages of the study.

Table 4. Recapitulation of Data Distribution Normality Test Results

Data	Class		Shapiro Wilk		Decision	Conclusion
			Statistic	Sig.		
Learning Interest	Experiment	Pre Test	0,935	0,066	Accept H_0	Normal
		Post Test	0,952	0,189	Accept H_0	Normal
	Control	Pre Test	0,942	0,105	Accept H_0	Normal
		Post Test	0,957	0,259	Accept H_0	Normal
Learning Outcomes	Experiment	Pre Test	0,935	0,065	Accept H_0	Normal
		Post Test	0,941	0,098	Accept H_0	Normal
	Control	Pre Test	0,939	0,086	Accept H_0	Normal
		Post Test	0,950	0,174	Accept H_0	Normal

Based on the results of the normality test above, it can be seen that the significance values for all data sets are greater than 0.05. Therefore, it can be concluded that all data are normally distributed.

Table 5. Recapitulation of Homogeneity Test Results for the Experimental and Control Class

Dependent Variable		F Test		Decision	Conclusion
		F count	F table		
Learning Interest	Pre Test	1,2334	1,86	Accept H_0	Homogeneous
	Post Test	1,1092	1,86	Accept H_0	Homogeneous
Learning Outcomes	Pre Test	1,2062	1,86	Accept H_0	Homogeneous
	Post Test	1,4578	1,86	Accept H_0	Homogeneous

Based on these results, it can be concluded that the data from both the experimental and control classes, as obtained from the learning interest questionnaire and the learning outcome test, have homogeneous variances (as all F count values are smaller than F table). This means no significant difference in variance between the two groups. Therefore, further statistical analysis can be conducted using parametric tests, namely the t-test, since the assumptions of normality and homogeneity have been fulfilled.

Table 6. Recapitulation of Hypothesis Test Results (Independent Sample t Test)

Post Test Data	df	t count	t table	Significance	Decision
Learning Interest Questionnaire	58	2,570	2,0017	0,013	Reject Ho
Learning Outcomes Test	58	3,540		0,001	Reject Ho

Based on the results of the t test for the learning interest questionnaire post-test, the significance value (Sig. 2-tailed) is 0.013, which is less than 0.05. Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. This indicates that the use of the Project-Based Learning model with a STEAM approach has a significant effect on the learning interest of Grade VII students at SMPN 1 Pancur Batu. Similarly, the post-test results for the learning outcome test show a significance value of 0.001, which is also less than 0.05. Thus, Ho is rejected, indicating that the Project-Based Learning model with a STEAM approach has a significant effect on students' mathematics learning outcomes.

The results of the independent samples t test show that both students' learning interest and learning outcomes improved significantly in the experimental class compared to the control class. This suggests that the implementation of the Project-Based Learning model based on the STEAM approach has a positive impact on both the learning process and outcomes in mathematics among junior high school students.

DISCUSSION

The Effect of the Project-Based Learning Model with a STEAM Approach on Students' Learning Interest

The research findings show that the implementation of Project-Based Learning (PjBL) with a STEAM approach has a significant and positive effect on students' learning interest. Based on the analysis of the pre-test and post-test learning interest questionnaires, there was a significant increase in the experimental class compared to the control class. This improvement occurred across all indicators of learning interest, namely enjoyment, attention, curiosity, and engagement.

Before the PjBL with STEAM learning was applied, both classes were given a questionnaire to measure students' learning interest, and the initial results showed no significant difference between the two classes. Therefore, this difference was not influenced by students' initial conditions, as both classes had relatively similar levels of interest in mathematics at the pre-test stage. The only distinguishing factor affecting the increase in learning interest was the learning model used, indicating that the difference in outcomes was truly caused by the PjBL-STEAM model and not by initial ability or external variables.

Research by Zhang, L., & Ma, Y. (2023) further revealed that students who learned using the Project-Based Learning model demonstrated higher self confidence than those who learned through conventional methods. Having self confidence fosters optimism, which plays a crucial role in students' development and, in turn, significantly increases their learning

interest. It is therefore not surprising that students' learning interest is higher when using the Project-Based learning model compared to conventional approaches. Project-Based learning serves as a method of instruction that uses real world problems as a starting point for gathering and integrating new knowledge through authentic, hands-on activities.

The project combined with the STEAM approach is considered effective in overcoming students' boredom and fear of mathematics, which is often perceived as a difficult and abstract subject. By incorporating elements of art and technology, students felt more enthusiastic and motivated to participate in learning. The increase in learning interest in the experimental class shows that the PjBL model with a STEAM approach provides a more engaging, meaningful, and real life learning experience. Learning is no longer teacher centered but requires students to be the main actors in constructing their own knowledge. With the integration of multiple disciplines and real world problem solving, students are more motivated to learn and perceive mathematics as flexible and applicable rather than rigid and purely theoretical.

Projects designed to be closely related to students' daily lives also enhance the relevance of learning and make mathematics feel more meaningful. In this approach, students are actively involved in designing, creating, and completing the project. The model provides opportunities for students to explore, discuss, design solutions, and collaboratively present their work, giving them a sense of ownership and importance in the learning process. In contrast, in the control class that used lecture based methods and routine exercises, the increase in learning interest was relatively lower. The lack of student involvement in the learning process was one of the reasons for their low enthusiasm and curiosity toward mathematics. Learning took place passively, with students mostly listening and following the teacher's instructions. This led to a lack of significant improvement in learning interest because students' active, emotional, and intellectual engagement remained low.

Dewey's concept of *learning by doing*, which states that direct experience is the key to meaningful learning. Students did not merely listen and take notes but engaged in a real creation process. This process fostered intrinsic motivation because students felt challenged and interested in completing their projects successfully. Thus, the observed increase in learning interest was not accidental but the result of a combination of factors: active involvement in the project, freedom to create, use of technology, and contextual experiences. All these factors complement one another, making PjBL-STEAM learning far more engaging than conventional methods.

This difference shows that a learning model that provides space for exploration, creativity, and collaboration, such as PjBL with a STEAM approach, is more effective in fostering students' interest in learning compared to conventional methods. STEAM-based PjBL not only emphasizes understanding mathematical concepts but also connects them to the real world, making the learning process more meaningful and enjoyable. Therefore, it can be concluded that the implementation of Project-Based Learning with a STEAM approach has a positive impact on increasing students' interest in mathematics and deserves to be considered as an innovative alternative teaching strategy in the classroom.

The Effect of the Project-Based Learning Model with a STEAM Approach on Students' Learning Outcomes

In addition to increasing learning interest, the Project-Based Learning (PjBL) model with a STEAM approach has also been proven to significantly improve students' learning outcomes. The results of the t-test showed a significant difference in the average scores between the experimental and control groups, with the experimental class that implemented PjBL-STEAM achieving higher scores. Prior to the treatment, a pre-test was administered to assess the initial abilities of both classes, and the results indicated that the two groups had

relatively similar or equivalent initial abilities. Since both groups started with comparable abilities, the difference in post-test scores can be attributed directly to the implementation of PjBL-STEAM.

Analysis of pre- and post-test cognitive test data revealed that students in the experimental class achieved significantly higher learning outcomes than those in the control class. Similar to the variable of learning interest, this difference was not influenced by the students' initial conditions, as both classes had relatively equivalent abilities at the pre-test stage. Therefore, the significant improvement in learning outcomes in the experimental class can be confidently attributed to the use of the Project-Based Learning model with a STEAM approach as the sole independent variable in this study.

Supporting these findings, Wijayanto, T., Supriadi, B., and Nuraini, L. (2020) reported that mathematics learning using a Project-Based Learning (PjBL) model with STEAM approach helps students gain deeper and more meaningful mathematical knowledge and allows them to explore various fields of science more extensively. Students not only learn but also directly apply the knowledge they acquire through targeted projects. Moreover, they integrate knowledge from other disciplines to complete their projects, thereby gaining a more effective and enriching learning experience.

In the experimental class, students were guided to solve real-world problems through projects that were carefully structured to integrate elements of STEAM (Science, Technology, Engineering, Art, and Mathematics). This process required them to think critically and creatively, collaborate effectively, and apply mathematical knowledge in relevant contexts, thereby deepening their understanding of the material. Moreover, active participation in project planning and execution helped students construct concepts meaningfully rather than merely memorizing formulas.

Conversely, in the control class that employed conventional learning methods, activities were primarily focused on direct instruction and routine exercises with limited contextual connection. Students tended to be passive, following the teacher's instructions procedurally. As a result, their understanding of mathematical concepts remained mechanical and confined to short-term retention, resulting in less optimal improvements in learning outcomes than in the experimental class.

The difference in learning outcomes between the two classes indicates that conventional teaching methods provide limited opportunities for students to construct their own knowledge actively. In contrast, the PjBL model with a STEAM approach enhances learning outcomes by offering a collaborative, applicable, and integrative learning experience that strengthens conceptual understanding and its application in real-life situations. These findings are consistent with several previous studies showing that project-based learning with a STEAM approach improves students' cognitive achievement by creating a more meaningful, enjoyable learning process that accommodates diverse learning styles.

Dewi and Sutriyani (2024) found that the STEAM learning model can significantly improve mathematics achievement. Through assigned project tasks, students become more interested in asking questions, engaging in discussions, and completing projects because the mathematical concepts embedded in the tasks are closely connected to their daily lives and experiences. Project-Based Learning makes the classroom atmosphere more engaging and stimulates students' enthusiasm for learning mathematics. As a result, they gain a deeper understanding of mathematical concepts, since completing the projects requires the application of mathematical knowledge.

Mathematics learning becomes more meaningful, enabling students to recognize and understand the practical benefits of mathematics in everyday life. Thus, learning mathematics is not merely about achieving high test scores or preparing for exams, but also about applying mathematical concepts to real-world situations. The project tasks foster motivation and

increase students' interest in learning, while also optimizing their learning outcomes. Consequently, students' interest and mathematics achievement are higher in classes using the Project-Based Learning model compared to those using conventional teaching methods.

Project-Based Learning model with STEAM approach has been proven to significantly improve students' interest and learning outcomes. This improvement occurs because the model (1) provides authentic learning experiences that connect mathematics to everyday life, (2) integrates the elements of Science, Technology, Engineering, Arts, and Mathematics harmoniously, and (3) creates opportunities for students to be creative, collaborative, and critical thinkers, resulting in deeper and more enduring conceptual understanding. Therefore, it can be concluded that the Project-Based Learning model with a STEAM approach is more effective than conventional instruction in improving the mathematics learning outcomes of seventh-grade students, as demonstrated by the higher post-test scores of the experimental class compared to the control class.

CONCLUSION AND SUGGESTIONS

Based on the findings, it can be concluded that the Project-Based Learning (PjBL) model with a STEAM approach significantly improved both students' learning interest and learning outcomes. Initially, the experimental and control classes showed no significant differences in interest or cognitive abilities. However, after the intervention, the experimental class demonstrated higher increases in learning interest and greater improvements in learning outcomes, indicating the effectiveness of the PjBL STEAM model in enhancing students' motivation and academic achievement.

Based on the research findings, several recommendations are proposed. Teachers are advised to apply the Project-Based Learning (PjBL) model with a STEAM approach in mathematics, adapting projects to students' needs and available resources. Schools are expected to support its implementation through teacher training, adequate facilities, and curriculum integration to strengthen 21st century skills. Students are encouraged to be active participants in project-based learning to improve understanding, critical thinking, collaboration, and responsibility. Finally, future researchers may use this study as a reference to further investigate the effectiveness of STEAM based PjBL on other mathematics topics, levels of education, or additional variables such as creativity and problem-solving ability.

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