



The Influence of STEAM-Based Project-Based Learning on Student Creativity at Pena Surabaya Homeschooling

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Abstract: Humans need to continue to innovate and develop by the progress of the times. Therefore, education is an essential pillar for producing the next generation, which will face challenges in the era of the Industrial Revolution. Their critical thinking skills, creativity, and self-development are very important to protect students from fierce competition. Therefore, the learning model is essential in forming students to produce a reliable generation. Science, Technology, Engineering, Art, and Mathematics (STEAM) is the right choice for students to train in creativity. This study aims to determine the creativity abilities of students at Homeschooling Pena Surabaya. The method used is experimental quantitative with 18 students as samples (total sampling) – data collection techniques through questionnaires, documentation, and observation. The statistical results state that a significant influence between STEAM-based Project Based Learning (PBL) learning on creativity, known from the $r_{\text{calculated}}$, is greater than the r_{table} ($10.096 > 2.131$). The maximum post-test score is 100 for one person and is included in the "Very High" category. The maximum post-test score is 70 for four people. The average post-test result is 81.67 and is included in the "Very High" category.

Abstrak: Kebutuhan manusia untuk terus berinovasi dan berkembang sesuai dengan kemajuan zaman. Oleh karena itu, pendidikan merupakan pilar penting untuk menghasilkan generasi penerus yang mampu menghadapi tantangan di era revolusi industri 4.0. Untuk melindungi siswa dari persaingan yang ketat, kemampuan berpikir kritis, kreativitas, dan pengembangan diri mereka sangat penting. Oleh karena itu, model pembelajaran memainkan peran penting dalam pembentukan siswa untuk mencetak generasi yang dapat diandalkan. Metode Science, Technology, Engineering, Art, and Mathematic (STEAM) menjadi pilihan yang tepat untuk digunakan dalam melatih kreativitas bagi peserta didik. Penelitian ini bertujuan untuk mengetahui kemampuan kreativitas peserta didik di Homeschooling Pena Surabaya. Metode yang digunakan adalah kuantitatif eksperimental dengan 18 peserta didik sebagai sampel (total sampling). Teknik pengumpulan data melalui kuesioner, dokumentasi, dan observasi. Hasil statistik yang diperoleh menyatakan bahwa ada pengaruh yang signifikan antara pembelajaran Project Based Learning (PBL) berbasis STEAM terhadap kreativitas yang diketahui dari r_{hitung} lebih besar dari r_{tabel} ($10.096 > 2.131$). 1 siswa mendapatkan nilai maksimum posttest yaitu 100 dengan kategori "Sangat Baik". Rata-rata posttest menunjukkan hasil 81.67 dan masuk dalam kategori "Sangat Baik".

A. Introduction

Education is the foundation for realizing the nation's ideals. Education has an essential role in producing the next generation with soft and hard skills to answer the challenges of the times. Developing skills and molding the national character is the overarching objective of National Education. The Industrial Revolution 4.0 has significantly impacted Education in the twenty-first century; therefore, creating dependable pupils requires an efficient learning paradigm. According to Freud Pervical and Henry Ellington (in Hikmah et al., 2021), innovation in Industry 4.0 must move into learning. The education sector needs to get updates in the learning system to equip students to face competition.

Learning that is often one-way and focuses on material makes students feel bored and unable to express their thoughts. Students who need more focus and often ignore lessons are a fundamental problem for this study. Students are capable and appear to have sufficient creativity but still need their creativity in learning activities (Salma et al., 2024). Excellent and correct teaching skills and abilities are one of the demands of an educator, so a teacher must be able to choose and use the right learning approach according to the material to be delivered (Sasongko et al., 2024) This will affect students' thinking and creativity (Arsy & Syamsulrizal, 2021). Teachers still Use conventional models in the learning process; students have different learning styles, and teachers still need to be fully able to facilitate students to think creatively (Diniyah, 2024).

Learning updates are needed so that students' creativity and critical thinking can be realized so that learning innovation can be improved. Learning innovation is a learning process for students that is designed, developed, and managed creatively using the best methods to create an exciting and enjoyable learning environment. Students can work as much as possible through learning innovation to improve their creative thinking skills. According to Dupri et al (2021), creative thinking skills are mental construction tasks that generate novel, beautiful, and constructive thoughts connected to mental imagery and stress logical and intuitive thinking. Thinking skills include: 1) Critical thinking and problem solving, 2) Communication and teamwork, and 3) Creativity and invention. This is based on the 21st-century learning method (Fatmah, 2021).

Critical thinking is the ability to solve problems with high thinking order skills. Critical thinking is analyzing situations based on facts and evidence to reach conclusions through a thinking process. Critical thinking is an essential ability for student progress. Critical thinking helps students make logical decisions, evaluate arguments, and analyze information thoroughly to accept new information while still understanding the context and meaning of each piece of information received (Fatmah, 2021). Critical thinking helps students learn to think creatively and solve problems, thereby helping students become more independent, creative, and responsible.

Communication and collaboration are essential for students' self-development. Effective communication allows students to share ideas, talk about concepts, and clarify their understanding of the learning material presented by the teacher (Undari et al., 2023). Students and teachers have the opportunity to collaborate, which results in a dynamic and

interactive learning environment. Students also have the opportunity to learn social skills, work together in groups, and learn to appreciate the views and conditions of others (Fitriyah & Ramadani, 2021). Teamwork helps students complete complex tasks, solve problems, and achieve common goals. Students in a collaborative and communicative learning setting are better able to think critically, be creative, and solve problems (Fitriyah & Ramadani, 2021). A learning environment that allows collaboration also encourages a sense of leadership and responsibility among students.

In this modern era, creativity and innovation are very important for the development of students. Practicing creativity can develop critical and analytical thinking skills that are very useful in facing the challenges of everyday life (Atiaturrahmaniah et al., 2022). Innovation involves applying creative ideas into tangible and valuable forms. Innovative students can solve problems creatively (Shalikhah et al., 2017). Students are better prepared to face the dynamics of the world of work in the future, especially in the 21st century, because innovation encourages them to continue learning and adapting to change (Budiyono et al., 2020). Creativity and innovation will not only make students more intelligent and more competitive. However, they will also become actors of change who can positively impact society and the surrounding environment.

As we enter the twenty-first century, the 4Cs – Critical thinking, Collaboration, Communication, and Creativity – are the foundation for student learning (Diniyah, 2024). One of the learning models that might offer excellent chances for students to demonstrate creativity is Project-Based Learning (PBL) (Annisa et al., 2018). As a result, learning models significantly impact students' capacity for creative thought in educational innovation. Munandar (2009) identified four markers of creativity: originality (thinking that is authentic), elaboration (viewpoint breadth), assessment (evaluation), fluency (thinking and acting with fluency), flexibility (assuming that is flexible), and originality (thinking that is authentic). Students with fluency in thought can pose a variety of queries. Flexibility of thought, usually referred to as flexibility, is the capacity of pupils to approach problems from multiple angles. Originality/originality is the ability of students to create their notions. The capacity of pupils to take in knowledge from instructors and their surroundings is referred to as their breadth of perspective/elaboration. Evaluation is the capacity to make decisions and fix errors (Pamungkas et al., 2024).

According to recent advancements, students can study more actively and creatively while using project-based learning (PBL). Additionally, this paradigm can support students' critical thinking and increase students' motivation and problem-solving skills (Sumardiana et al., 2019). According to Rahma & Kurniawati (2024), the project-based learning paradigm, which emphasizes students finishing assignments on time, facilitates problem-solving and highlights student production (Jeniver et al., 2023). Students must use the project-based learning model to demonstrate their new knowledge in various ways. Thus, project-based learning allows students to learn authentically while honing their creative skills.

The STEM (science, technology, engineering, art, and mathematics)--based learning method offers a technique to boost thinking and creativity. In addition, this approach can

also be used as a project-based learning model (Annisa et al., 2018). STEAM is integrated learning that can improve students' problem-solving, critical thinking, and creative abilities (Atmojo et al., 2024). STEAM has been designed to be very adaptable to teaching styles so that it refers to an interdisciplinary approach to the Education of various academic concepts that are juxtaposed with the natural world by applying the principles of mathematics, science, technology, art, and engineering (Naili, 2021).

Pena Surabaya homeschooling is one of the non-formal schools under investigation. The study aims to determine how creatively students using the STEAM-based Project Based Learning learning approach can think. With a B certification and official recognition from the Indonesian Ministry of Education and Culture, Homeschooling Pena Surabaya is an alternative educational institution. This organization offers the Homeschooling Pena curriculum's elementary, junior high, and high school levels. With this program, students can opt to study from home or at a different location that the instructor has designated.

Generally, PBL with the STEAM approach is widely applied in formal schools and has yet to be widely applied in non-formal schools, so its application in Homeschooling Pena Surabaya can fill the gaps in previous research. In addition, PBL usually discusses student learning outcomes, and few discuss increasing student creativity. Therefore, this study attempts to discuss the novelty that has different results from before

The significance of enhancing learning models in developing 21st-century abilities required for daily living and the workplace is vital for this research. While most other academics focus on formal schools, researchers are interested in measuring kids' creativity from non-formal schools. This study aims to examine how the STEAM-based Project Based Learning approach at Homeschooling Pena Surabaya may impact the creative talents of class VII pupils, taking into account the problem's historical context. This study raises educational standards and generates a new generation of highly skilled and creative problem solvers.

B. Method

A questionnaire is used in this study's experimental quantitative data collection strategy. Understanding observed behavior, searching for relationships between variables/events, synthesizing specific variables, summarizing tested conditions, comprehending a wide range of conditions, characterizing controlled phenomena for theory testing, challenging variables according to the researcher's perspective, needing context-free generalization, linear/unidirectional and statistical data tests, data sources from respondents/samples, and hypotheses that must be clear because they will be tested in the field are all examples of quantitative research (Barlian, 2016). The research flow can be seen in Figure 1.

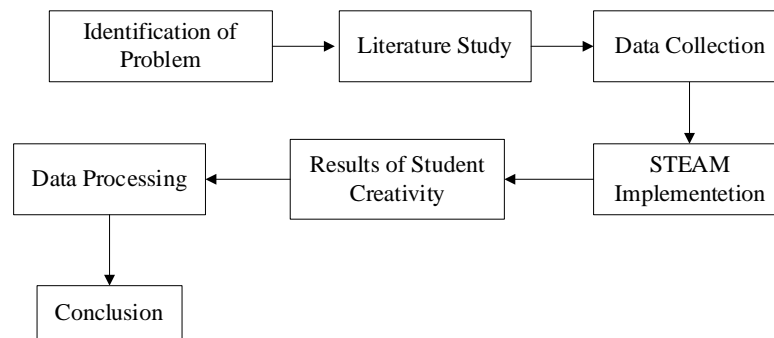


Figure 1. Research Flow

This study employs two variables: student creativity (dependent variable) and project-based learning material using the STEAM approach (independent variable). Documentation, observations, and questionnaires were used to gather primary data. Secondary data were gathered from online resources and literature reviews. Total sampling, in which the number of samples is equal to the Population, was the sampling strategy employed (Sugiyono, 2019). Eighteen pupils in class VII (pursuit package B) at Homeschooling Pena Surabaya served as the sample. Students at Homeschooling Pena Surabaya are taught using the Project Based Learning (PBL) paradigm in Natural Science classes, which incorporates the STEAM approach. SPSS software was utilized to assist with data analysis and assess hypotheses, normality, heteroscedasticity, validity, and reliability. Activity observation sheets, pretest-posttest questionnaires, and Likert scale questionnaires were the tools utilized. Students took the pretest to gauge their level of creativity before receiving the STEAM-based PBL application therapy. The post-test was conducted after the treatment to establish pupils' final creativity abilities, which could later be contrasted and their effectiveness measured. A one-group pretest-posttest design is used in this study (Indahwati et al., 2023), as in Table 1.

Table 1. One Group Pretest-Post-test Design

Pretest	Treatment	Post-test
A1	X	A2

Explanation:

A1 : Pretest of creativity ability

X : Implementation of STEAM-based PBL learning model

A2 : Post-test of creativity ability

The increase in student creativity can be measured based on the indicators used. STEAM indicators function to stimulate and assess creativity (Safriana, et al., 2022) – meanwhile, creativity indicators function as a guide in evaluating various aspects of students' creative abilities. Determining the right indicators allows teachers to get a more

accurate picture of the potential and development of student creativity. The creativity indicators used are in Table 2.

Table 2. Creativity Indicator

Creativity Indicator	Description	Activity
Fluency	The ability of students to generate many ideas or responses to a problem	Changing elements such as the size of the planets, the number of planets, and their order in the solar system
Flexibility	The ability of students to see problems from various perspectives and create a variety of solutions	Presenting solar system designs and receiving feedback from other students
Originality	The ability of students to produce unique and different ideas and concepts	Write a short script that tells about the interactions between one planet and another in the solar system
Elaboration	The ability of students to develop and enrich the ideas that have been produced, detail the ideas, and provide details about the ideas	Make a detailed description of the planets in the solar system.

The results of the pretest and post-testposttest, each consisting of 10 questions, measure students' creativity. Therefore, there must be a category of creativity assessment to group students' abilities. Table 3 shows the determination of the level of student creativity category using the Graded Response Model (Riduwan, 2009).

Table 3. Creativity Category Percentage

Category	Percentage
Very Low	0-20
Low	20-40
Average	40-60
High	60-80
Very High	80-100

C. Result and Discussion

Result

Statistical data was obtained from the questionnaire, pretest, and post-test results of class VII Pena Surabaya Homeschooling students. The following are the output results from the SPSS software related to the data feasibility test.

Validity and Reliability Test

A validity test refers to the extent to which an instrument measures what it should measure. A reliability test is conducted to determine the stability of the results obtained from a measurement instrument when used under the same conditions at different times. The

results of the questionnaire validity test to measure students' creativity abilities are in Table 4.

Table 4. Questionnaire Validity Test Results

Item	Pearson Correlation	Sig. (2-tailed)	Criteria
Q1	0.950	0.000	Valid
Q2	0.837	0.000	Valid
Q3	0.763	0.000	Valid
Q4	0.907	0.000	Valid
Q5	0.507	0.002	Valid
Q6	0.950	0.000	Valid
Q7	0.696	0.001	Valid
Q8	0.756	0.000	Valid
Q9	0.930	0.000	Valid
Q10	0.669	0.002	Valid
Q11	0.929	0.000	Valid
Q12	0.946	0.000	Valid
Q13	0.920	0.000	Valid
Q14	0.800	0.000	Valid
Q15	0.802	0.000	Valid
Q16	0.932	0.000	Valid
Q17	0.833	0.000	Valid
Q18	0.731	0.000	Valid
Q19	0.814	0.000	Valid
Q20	0.648	0.004	Valid

Data processed by researchers, 2024

Based on Table 4, the question items are declared valid because the Pearson correlation value is more than 0.05 and the sig. (2-tailed) value of each item is less than 0.05. The results of the questionnaire reliability test to measure students' creativity abilities are in Table 5.

Table 5. Questionnaire Reliability Test Results

Reliability Statistics	
Conbach's Alpha	N of Items
.924	8

The reliability test results in Table 5 show that the questionnaire instrument can be declared reliable because the Cronbach's alpha value is greater than the r table ($0.924 > 0.7$).

Normality Test

The normality test is utilised to ascertain whether or not the sample data is distributed normally. Because fewer than 30 respondents are in the sample, the Shapiro-Wilk method is used for the normalcy test in this study. The following are the results of the normality test in Table 6.

Table 6. Questionnaire Normality Test Results

	Test of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
X	.114	18	.200	.961	18	.621
Y	0.88	18	.200	.978	18	.923

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance

Based on Table 6, the questionnaire values for the STEAM variable (X) and the creativity variable (Y) are normally distributed because the significant values are greater than 0.05 ($0.621 > 0.05$ and $0.923 > 0.05$).

Heteroscedasticity Test

The heteroscedasticity test is a regression analysis determining whether heteroscedasticity exists in a regression model. This study employs the geysers approach, which regresses the absolute value of the residual against the independent variable. If the coefficient of the independent variable is substantial, it indicates heteroscedasticity. The following are the results of the heteroscedasticity test in Table 7.

Table 7. Heteroscedasticity Test Results

Model	Coefficients ^a				
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	3.398	1.577		2.154	0.47
X	-.027	.039	-.166	.674	.510

a. Dependent Variable: ABS_RES

Based on Table 7, the significance value is greater than 0.05 ($0.510 > 0.05$), so there is no heteroscedasticity. Variable X (STEAM Learning) does not significantly affect the dependent variable ABS_RES (residual) in this study.

R Square Test

The R square test (or coefficient of determination) is a measure in statistics used to assess how well a linear regression model explains the variability of the dependent data. The R square value ranges between 0 and 1. If R square = 0, then the model cannot explain the variability of the data at all. If R square = 1, then the model can perfectly explain all the data variability. If R square approaches 1, then the model can explain the variability of the data. The following are the results of the R Square test in Table 8.

Table 8. R Square Test Results

Model Summary ^b				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.930 ^a	.864	.856	3.343

a. Predictors: (Constant), X

b. Dependent Variable: Y

Table 8 shows the R square value of 0.864 and concludes that STEAM learning (X) has an influence of 86.4% on the creativity (Y) of Pena Surabaya Homeschooling students.

T-test

The T-test is a type of statistical test used to compare the means of two sample groups and determine whether there is a statistically significant difference between them. The results of the T-test are in Table 9.

Table 9. T-test Results

Model	Coefficients ^a				t	Sig.
	Unstandardized Coefficients	Standardized Coefficients		Beta		
	B	Std. Error	Beta			
1 (Constant)	1.809	2.454		.737	.472	
X	.619	.061	.930	10.096	.000	

The T-test results in Table 9 show that the significance value is less than 0.05 ($0.000 < 0.05$), and the calculated t value is greater than the t table ($10.096 > 2.131$), indicating that the significance value of STEAM learning (X) on the creativity of Homeschooling Pena Surabaya students (Y) is rejected (H_0) and H_1 is accepted.

Results of Measurement of Students' Creativity Abilities

The pretest aposttestest instruments are used to sif any improvements that indicate that the intervention or teaching applied (variables X and Y) is effective in improving the measured result Table 10 recapitulates the posttestest of Homeschooling Pena Surabaya stude, and Table 11 summarizes of the pretest aposttest scores 11.

Table 10. Post-test Recapitulation Results

Respondent	Post-test Value	Category
P1	90	Very High
P2	80	Very High
P3	90	Very High
P4	70	High
P5	100	Very High
P6	80	Very High

Respondent	Post-test Value	Category
P7	80	Very High
P8	80	Very High
P9	80	Very High
P10	70	High
P11	90	Very High
P12	70	High
P13	90	Very High
P14	80	Very High
P15	70	High
P16	80	Very High
P17	90	Very High
P18	80	Very High

Data processed by researchers, 2024

Based on Table 10, the post-test results of applying STEAM on student creativity were 100 for one person, 90 for five people, 80 for 6 people, and 70 for 4 people. The maximum value recorded was 100 and the minimum value was 70. According to this analysis, most students scored 80 and 90, indicating a "Very High" level of creativity.

Table 11. Descriptive Statistics Results of Pretest and Post-test Scores

	Pretest	Posttest
Mean	63.89	81.67
Median	70.00	81.30
Std. Deviation	7.775	8.575
Minimum	50	70
Maksimum	70	100
Range	20	30

Based on Table 10, the average pretest result is 63.89, the median value is 70.00, the minimum value is 50, and the maximum value is 70. The average post-test result is 81.67, the median value is 81.30, the minimum value is 70, and the maximum is 100. This shows that the level of student creativity increased after the STEAM learning treatment in science subjects.

Discussion

This study focuses on the STEAM-based Project Based Learning (PBL) model's influence on increasing student creativity at Homeschooling Pena Surabaya. Education in this modern era demands creativity and innovation as essential skills students must have to face future challenges. This study uses experimental quantitative methods to test the validity, reliability, normality, heteroscedasticity, R square, T-test, and students' creativity abilities. The following is a detailed discussion of each aspect.

This study is in line with the study conducted by [Annisa et al \(2018\)](#) entitled "Peningkatan Kemampuan Berpikir Kreatif Siswa dengan Menggunakan Model Project

Based Learning Berbasis STEAM (Science, Technology, Engineering, Arts dan Mathematic) pada Materi Asam dan Basa di SMAN 11 Kota Jambi" which states that data analysis used the paired samples t-test, the average value of the pretest was 1.58, and the post-test was 3.17. The correlation results between the pretest-posttest scores were $0.263 > 0.05$, meaning there was no relationship between the pretest-posttest scores. The 2-tailed significance value is $0.000 < 0.05$, so there is a real difference in students' creative thinking abilities in the pretest and post-test. Based on the research results, there is a real difference in students' creative thinking abilities with using the project-based learning model in acid and base material at SMAN 11 Kota Jambi.

Based on the results of observations and assessments in the pretest and post-test, students' creativity increased rapidly. The results of the abilities of Homeschooling Pena Surabaya students after the STEAM-based PBL learning treatment obtained an average score of 81.67, which is included in the "Very High" category, namely in the 80-100 category range. This shows that the ability to be creative in science subjects has increased from the previous 70.00, which is included in the "High" category in the 60-80 range. This shows that students' creativity abilities are good but need improvement to get maximum results.

D. Conclusion

This study successfully showed that the STEAM-based Project Based Learning model significantly increased students' creativity at Homeschooling Pena Surabaya. Based on statistical tests, there was a positive influence between STEAM learning and creativity, with the average post-test results reaching the "Very High" category. This indicates that the STEAM approach effectively improves academic skills, encourages students to think creatively and collaboratively, and improves problem-solving and critical thinking skills.

The findings of this study make a significant contribution to the field of Education, particularly in the non-formal sector. Project-based learning with a STEAM approach in a homeschool setting has enormous potential for increasing student creativity. Teachers can use this technique to encourage more active student participation in the learning process, better preparing them to confront the challenges of the twenty-first century, which require creative and innovative talents. Furthermore, this approach can be applied to several other subjects to increase the quality of learning.

Further research is suggested to expand the research sample, not only in homeschooling but also in various formal and informal schools. In addition, further studies can focus on the influence of STEAM implementation on non-academic aspects, such as character development or students' social skills. Additional exploration related to technology integration in STEAM-based learning models can provide new perspectives on how technology can better support students' creativity and innovation in educational contexts.

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