

The Effect of the EDP Learning Model Based on the STEAM Approach to Stimulate Students' CPS Skills and Biological Science Literacy on Environmental Knowledge Materials at State Middle School 3 Ternate City

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ABSTRACT

This study uses the Engineering Design Process learning model based on the STEAM approach to stimulate students' CPS skills and biological science literacy on environmental knowledge material at SMP Negeri 3 Ternate City. This study was conducted using quantitative methods. The results of the study showed that there was an influence of the Engineering Design Process model based on the STEAM approach to stimulate students' CPS skills and biological science literacy on environmental knowledge material at SMP Negeri 3 Ternate City. The results of data analysis that have been carried out through normality and homogeneity tests with the EDP model based on the STEAM approach applied in the experimental class can achieve higher CPS and scientific literacy indicators compared to the control class. It can be concluded that there is an influence of the EDP model based on the STEAM approach to stimulate students' CPS skills and biological science literacy on environmental knowledge material at SMP Negeri 3 Ternate City.

INTRODUCTION

Science, Technology, Engineering, Art, and Mathematics (STEAM) is a 21st-century learning approach that integrates science, technology, engineering, mathematics, and art into the learning process. STEAM is an integrated learning approach that encourages students to think more broadly about real-world problems. STEAM (Science, Technology, Engineering, Arts, and Mathematics) is an integrated learning approach that encourages students to think critically, creatively, and innovatively in solving various real-world problems. This approach integrates the disciplines of science, technology, engineering, the arts, and mathematics into a holistic learning process so that it can be effectively implemented in a school setting (Nurhikmayati, 2019). STEAM, which stimulates creative problem solving (CPS), is a learning model that places greater emphasis on creativity as a foundational skill for students in solving problems. Creativity is a person's ability to produce something new – whether an idea or a tangible work – manifesting in both aptitudinal and non-aptitudinal characteristics, or through a combination of existing elements that are relatively distinct from what already exists (Suryosubroto, 2009).

STEAM (Science, Technology, Engineering, Arts, and Mathematics) is an integrated learning approach that combines science, technology, engineering, the arts, and mathematics to develop students' investigative, communication, and critical thinking skills during the learning process (Riley, 2019). The STEAM approach also emphasizes the interconnections between two or more disciplines as the foundation for learning through observation, inquiry, and problem-solving activities. In line with the demands of 21st-century learning, this approach encourages students to develop creativity, critical thinking, collaboration, and communication skills so they can innovatively tackle various life challenges (Riley, 2019).

The STEAM learning approach is typically integrated with other learning models and is specifically designed to provide disciplined and contextual learning experiences. One of the key strengths of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach is its ability to encourage students to think creatively and critically when solving real-world problems. Through the application of the Engineering Design Process (EDP) steps, STEAM stimulates creative problem-solving skills while enhancing students' science literacy, including in biology education (Bybee, 2013; Kelley & Knowles, 2016; National Research Council, 2012).

Based on the results of observations using interviews conducted by the researcher at SMP Negeri 3 in Ternate, it was found that the school uses the Merdeka Curriculum; there are four biology teachers teaching the biology subject to a total of 180 seventh-grade students. From the results of these interviews, it was found that the learning process does not yet utilize the EDP learning model; however, the STEAM approach has been taught by teachers to students. Similarly, while the stimulation of CPS skills is not yet known to the teachers, science literacy has already been implemented. The STEAM approach and biology science literacy have been taught by teachers but not through research, so the teachers do not know the extent of the success of implementing these

science literacy approaches. Based on this data, the researcher conducted a study to implement a STEAM-based EDP learning model to stimulate CPS and biology science literacy.

THEORETICAL REVIEW

Nurhikmawati (2019) states that STEAM (Science, Technology, Engineering, Arts, and Mathematics) is an integrated learning approach that encourages students to think critically, creatively, and innovatively in solving various real-world problems. This approach integrates the disciplines of science, technology, engineering, the arts, and mathematics into a holistic learning process so that it can be effectively implemented in a school setting.

STEAM (Science, Technology, Engineering, Arts, and Mathematics) is an integrated learning approach that combines science, technology, engineering, the arts, and mathematics to develop students' investigative, communication, and critical thinking skills during the learning process (Riley, 2019). The STEAM approach also emphasizes the interconnections between two or more disciplines as the foundation for learning through observation, inquiry, and problem-solving activities. In line with the demands of 21st-century learning, this approach encourages students to develop creativity, critical thinking, collaboration, and communication skills so they can innovatively tackle various life challenges (Riley, 2019).

METHODOLOGY

Research Design

This study employs a quantitative research design using a quasi-experimental design. According to Sugiyono (2015), a quasi-experimental design is a research approach that closely resembles a true experiment. This study aims to directly test the effect of one variable on another and to test the hypothesis of a cause-and-effect relationship. A quasi-experimental design includes an experimental group and a control group; however, the control group cannot fully control external variables that influence the conduct of the experiment.

Research Design

This study is a type of quasi-experimental research and includes a control group. The quasi-experimental design used is a randomized control group pretest-posttest design. In this design, the experimental class is a Biology class that uses a STEAM-based EDP learning model to stimulate CPS skills and Biology science literacy. The implications of using the STEAM-based EDP model to stimulate CPS skills and biology science literacy will be tested at the end of the study after the treatment has been administered to the experimental class. This research design is presented in the table below.

Table 1. Research Design

<i>Pre-test</i>	<i>Treatment</i>	<i>Post-test</i>
O_1	X	O_2
O_1	X	O_2

Research Location and Time

This study was conducted at SMP Negeri 3 Ternate City in two seventh-grade classes. The research was carried out in January 2026.

Population and Sample

1. Population

The population in this study consists of 45 seventh-grade students at State High School 4 in Ternate City.

2. Sample

The sample is a subset of the population. According to Setyosari (2016), the sample selected for this study consists of two classes: Class VII Group 1 (23 students) as the experimental class using the STEAM-based EDP learning model, and Class VII Group 2 (22 students) as the control class using the EDP learning model.

Data Collection Methods

The data collection methods used in this study include tests, interviews, observations, and documentation.

1. Tests

The tests used in this study consist of multiple-choice science literacy questions designed to assess aspects of science literacy knowledge – such as understanding scientific phenomena – and science competency, including the use of scientific evidence. The purpose of administering this science literacy test is to determine the CPS skills and science literacy possessed by students at SMP Negeri 3 Kota Ternate.

2. Observation

Observation was conducted to understand the realistic conditions of the research subjects, namely the students at SMP Negeri 3 in Ternate City.

3. Documentation

This method was used to gather data regarding various matters or variables in the form of notes, transcripts, books, newspapers, magazines, inscriptions, meeting minutes, ledgers, agendas, and so on.

Data Analysis Techniques

The data analysis techniques used in this study are as follows:

1. Analysis of CPS Skills and Science Literacy

Science literacy was analyzed using the formula below; that is, the data obtained was calculated and evaluated by assigning scores. After all test items and student answers have been scored, the next step is to calculate the percentage of the answer score for each item using the following formula:

$$\frac{\text{score obtained}}{\text{Total score}} \times 100$$

Table 2. Assessment of CPS Skills and Science Literacy

No	Percentage of answers	Grading criteria
1	81-100	Very high
2	61-80	High
3	41-60	Moderat
4	21-40	Low
5	<20	Very Low

1. Normality Test

A normality test was conducted to determine whether the data obtained from the population followed a normal distribution using the Lilliefors formula (Wati, 2016).

2. Homogeneity Test

This test was used to determine the similarity between two conditions or proportions. The homogeneity test used was the two-variance homogeneity test, also known as Fisher's test.

3. Hypothesis Testing

The hypothesis test in this study is an ANCOVA to determine whether there are differences between each category of EDP learning models based on the STEAM approach in improving students' science literacy.

RESULTS

Creative Problem-Solving Data in the Experimental and Control Classes

The results consist of data on the pre- and post-test performance of students in the experimental and control classes before the intervention, while the post-test results reflect the students' performance after the intervention—which involved using the EDP model based on the STEAM approach in the experimental class, whereas the control class used the standard EDP learning model.

Analysis of students' creative problem-solving skills before and after instruction using the STEAM-based EDP model (VII1) and instruction using the EDP model (VII3). This study was conducted at SMP Negeri 3 in Ternate during the 2025/2026 academic year. The population in this study consisted of all seventh-grade students across six classes, and the sample comprised Class VII1 as the experimental group and Class VII3 as the control group. The study aimed to determine whether there was a difference in students' creative problem-solving skills between learning using the EDP model based on the STEAM approach and learning without the STEAM approach.

After the data was obtained from the students' pretest and posttest results, it was analyzed using descriptive statistics, namely the maximum, minimum, and mean values. The instrument used was the creative problem-solving test, which was administered to both the experimental and control classes before the treatment was applied.

Based on the calculation data, the sample sizes differed between the experimental and control classes—23 for the experimental class and 22 for the control class—resulting in a pre-test mean score of 37.54 for the experimental class and 76.81 for the post-test, while the control class had a pre-test mean score of 32.18 and a post-test mean score of 65.64. The presentation of data based on creative problem-solving can be seen in Figure 4.1 below:

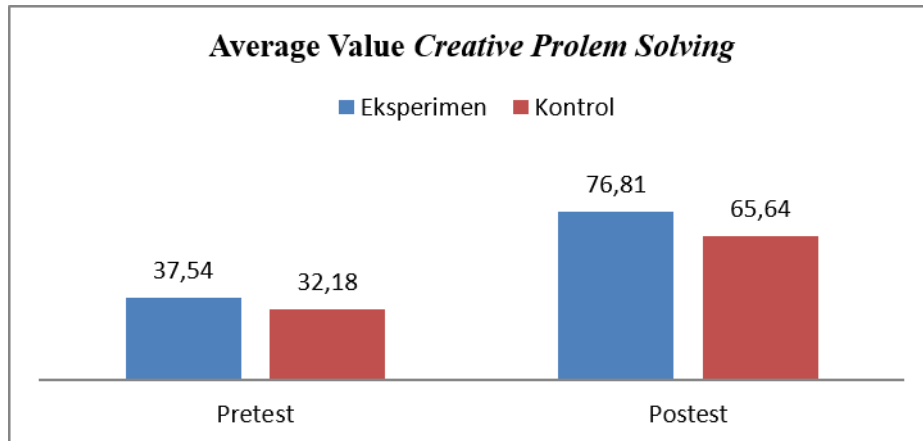


Figure 1. Test Results for Creative Problem Solving

Based on Figure 1, the pretest and posttest results for Creative Problem Solving (CPS) skills show an improvement in both classes. The average pretest score for the experimental class was 37.54%, while that for the control class was 32.18%, indicating that the initial abilities of both groups were still relatively low. After the intervention, the average posttest score in the experimental class—which received instruction using the Engineering Design Process (EDP) model based on the STEAM approach—increased to 76.81%. Meanwhile, the control class, which followed instruction using the EDP model without the STEAM approach, achieved an average posttest score of 65.64%. These results show that the implementation of the STEAM-based EDP model resulted in a greater improvement in Creative Problem Solving skills compared to learning using the EDP model alone.

Science Literacy Data for Students in the Experimental and Control Classes

The science literacy data in this study describe the initial (pretest) and final (posttest) abilities of students in the experimental and control classes. The same instrument was used for both the pretest and posttest so that the measurement results could be compared consistently. In the experimental class, instruction was conducted using the Engineering Design Process (EDP) model based on the STEAM approach, while the control class used the Engineering Design Process (EDP) model without the STEAM approach. After all treatments were administered, pretest and posttest science literacy data were collected to analyze changes in students' science literacy abilities in both groups.

Based on the calculation results, it can be seen that with a different sample size between the experimental class (23 samples) and the control class (22 samples), the experimental class achieved a higher average score in student

science literacy than the control class. This can be observed from the average pretest score of the experimental class (39.81) and posttest score (73.83), which are higher than the average pretest score of the control class (33.18) and posttest score (63.45). Furthermore, the pretest and posttest data from both classes were calculated based on each science literacy question administered, as shown in the diagram below:

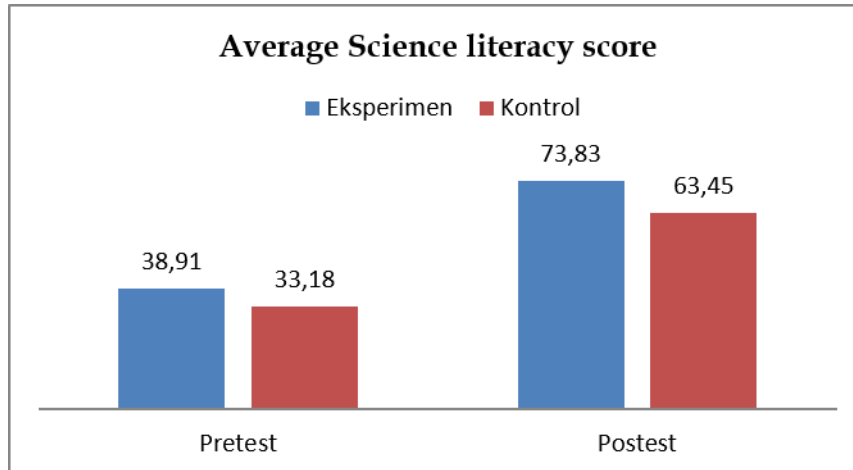


Figure 2. Data on students' science literacy test results

Based on Figure 2, the posttest results for science literacy show that students in the experimental class who participated in instruction using the Engineering Design Process (EDP) model based on the STEAM approach achieved an average score of 73.83, while students in the control class who participated in instruction using the EDP model without the STEAM approach achieved an average score of 63.45. This difference in average scores indicates that the implementation of the STEAM-based EDP model yields better results in improving students' science literacy compared to instruction that uses only the EDP model without the STEAM approach.

a. Normality Test for Students' Creative Problem Solving

The normality test aims to determine whether the data is normally distributed or not. The results of data analysis using the Kolmogorov-Smirnov test indicate that if $\text{sig.} \geq 0.05$, then H_0 is accepted; in other words, the data is deemed to be normally distributed.

Table 3. Results of the Normality Test for Creative Problem Solving

Tests of Normality

Class	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Exsperiment Class Pretest	.288	11	.200	.771	11	.190
Exsperiment Class Posttest	.191	11	.200*	.966	11	.844
Control Class Pretest	.206	11	.200*	.900	11	.184
Control Class Posttest	.164	11	.200*	.960	11	.773

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test for creative problem solving among the students above, the normality test results for the Pre-Test and Post-Test groups indicate that all data are normally distributed.

b. Homogeneity Test for Students' Creative Problem Solving

The homogeneity test was conducted to determine whether the variance within a group is homogeneous or not. This test was performed on both the Pre-Test and Post-Test data for the experimental and control classes. The null hypothesis (H_0) is accepted if the significance level (sig.) is ≥ 0.05 . The results of the homogeneity test are presented in Table 4 below:

Table 4. Homogeneity Test for Students' Creative Problem Solving
Test of Homogeneity of Variance

	Levene Statistic	df1	df2	Sig.
Based on Mean	1.099	3	40	.361
Based on Median	.743	3	40	.533
Based on Median and with adjusted df	.743	3	34.810	.533
Based on trimmed mean	1.078	3	40	.370

Based on Table 4, the results of the homogeneity test show that the significance value (Sig.) Based on Mean is 0.132, which is greater than the significance level of 0.05 ($p > 0.05$). Thus, it can be concluded that the variances of the pretest and posttest data in the experimental class and the posttest data in the control class are homogeneous. These results indicate that the data satisfy one of the assumptions required for conducting parametric statistical analysis in the next stage.

c. Normality Test for Students' Science Literacy

The normality test is a prerequisite test aimed at determining whether data follows a normal distribution. If the data is normally distributed, parametric statistical methods can be used for hypothesis testing; conversely, if the data is not normally distributed, non-parametric statistical methods must be used. In this study, the normality test of the data was conducted using the Kolmogorov-

Smirnov test (Sutiarso, 2022). Table 4.3 below presents the results of the normality test conducted using the Kolmogorov-Smirnov test.

Table 5. Test of Normality for Students' Science Literacy
Tests of Normality

	Class	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Result	Experimental Class Pretest	.106	12	.200*	.959	12	.773
	Exsperimental Class Posttest	.259	12	.025	.839	12	.027
	Control Class Pretest	.203	11	.200*	.910	11	.243
	Control Class Posttest	.347	11	.001	.665	11	.000

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 5 shows the results of the normality test for the pre-test and post-test groups, with the final result indicating that all data are normally distributed.

d. Homogeneity Test for Students' Science Literacy

The homogeneity of variance test for the sample classes aims to determine whether the two samples come from a homogeneous population or not; in other words, whether the samples used in this study can represent the entire existing population or not. The results of the homogeneity of variance test for the pre-test sample classes are shown in Table 6.

Table 6. Homogeneity Test of Students' Science Literacy
Homogeneity Test of Students' Science Literacy

	Levene Statistic	df1	df2	Sig.
Result	Based on Mean	2.191	3	.103
	Based on Median	1.803	3	.161
	Based on Median and with adjusted df	1.803	3	.165
	Based on trimmed mean	2.125	3	.111

Based on the table above, the sig. value based on the mean of 132 is greater than 0.05; therefore, it can be concluded that the variances of the post-test data for the experimental and control groups are homogeneous.

DISCUSSION

The analysis results of students' scientific literacy before and after instruction using the EDP learning model based on the STEAM approach (Class VII1) and the EDP learning model (Class VII3) were examined. The study was conducted from Tuesday, January 13 to January 24, 2026, at State Junior High School 3 Ternate City. Based on the findings, the researchers identified several aspects that became the

focus of this study, including the effect of the EDP learning model based on the STEAM approach on improving students' Creative Problem Solving (CPS) skills and scientific literacy. The sample consisted of students from Class VII1 as the experimental group and Class VII3 as the control group.

The Effect of a STEAM-Based EDP Learning Model on Stimulating Students' Creative Problem Solving

The STEAM approach is inseparable from the EDP (Engineering Design Process); the two are interrelated and share common stages in the learning process. According to Ulum (2021), the EDP and STEAM stages consist of six steps: define, learn, plan, try, test, and decide. Integrating the STEAM approach into EDP aims to enhance students' ability to solve problems and provide solutions. This approach enables students to develop their own critical and creative thinking through a structured learning process using instructional materials such as lesson plans and modules.

The Effect of the STEAM-Based EDP Learning Model on Stimulating Students' Science Literacy

The problem-based EDP model is designed to provide students with essential knowledge in the classroom that enables them to become proficient in problem-solving and skilled in team participation. Problem-based learning was developed to help students develop thinking skills, problem-solving abilities, and intellectual skills, and students can adapt well to STEAM-based EDP learning (Desriyanti, 2016).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the data analysis and discussion, the following conclusions are drawn:

1. There is an influence of creative problem solving and students' science literacy. Based on the research and data analysis conducted through an ANOVA hypothesis test, a significance level of less than 0.05 was obtained ($0.000 < 0.05$), indicating that the null hypothesis (H_0) is rejected. Thus, it is known that the EDP model with a STEAM approach on environmental knowledge material has an effect on stimulating students' creative problem-solving skills and biology science literacy in environmental knowledge material at Ternate City Public Junior High School Number 3.
2. The effect of creative problem-solving and students' science literacy using the STEAM-based EDP model on environmental knowledge material in the experimental class is more significant.

FURTHER STUDY

This study was conducted at only one school, namely SMP Negeri 3 in Ternate City. Therefore, the findings cannot yet be broadly generalized to all junior high school students in Ternate City. The application of the STEAM-based EDP learning model in this study was focused solely on Environmental Science content. Consequently, the effectiveness of this model for other Biology topics, such as organ systems, genetics, or biodiversity, remains uncertain. The success

of implementing the STEAM-based EDP model is highly influenced by teacher readiness, the availability of facilities and infrastructure, and active student participation. Differences in teachers' abilities to manage learning and limitations in school facilities can affect the effectiveness of the model's implementation. Further research is recommended to Include more schools with diverse characteristics, Extend the duration of the study to assess long-term effects and Test the application of the STEAM-based EDP model to other biology topics.

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