Implementation Of PBL-STEAM Model to Improve Student Learning Outcomes on The Material Environmental Pollution

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Abstract. A multidisciplinary approach in education through STEAM needs to be optimized to improve contextual learning outcomes and impact real life. Efforts should be made to integrate the PBL and STEAM models in learning related to the environment. The purpose of this study is to analyze the application of the PBL-STEAM model in improving student learning outcomes related to environmental pollution materials. The method in this study is a quantitative descriptive study with a pretest-posttest control group design. The PBL model is applied to student group control, and the PBL-STEAM model is applied to student group experiments on materials pollution environment. Data collection techniques include tests, observations, and interviews. Samples in this study are students in class VII semester two at one of the school media in the first country in Sambas Regency and Bengkayang Regency, West Kalimantan Province. The sampling technique is in the form of purposive sampling. Data analysis techniques with count N-Gain score, and percentage score results observation and interviews. Found that there is an improvement in scores in the group experiment compared to the group control, with the N-Gain score in the category height. The sheet results observation of learning activities and interview questionnaire sheets in the form of student response sheets showed a high category. Conclusion: This study, namely the implementation of the PBL-STEAM model, can improve student learning outcomes in environmental pollution. It is hoped that PBL- STEAM can also be applied to other materials.
Keywords: PBL, STEAM, Contextual learning, Environmental pollution.

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1. Introduction

A multidisciplinary approach is one of the goals in curriculum development to build optimal learning. This approach is more directed at STEAM (Science, Technology, Engineering, Art, and Mathematics) learning. Integrated learning with STEAM needs to be implemented to improve contextual learning outcomes and impact real life. This is achieved through the integration of PBL (Problem-Based Learning) and STEAM (PBL-STEAM) models in environmental-related subject matter.

This research focuses on the application of the PBL-STEAM model because this model presents problems that need to be solved using a multidisciplinary approach (STEAM). The application of the PBL model provides a chance for students to become more active thinkers and understand material in a way that groups with studying real problems in life. This is expected to give an understanding and to learn more deeply about what they learn. The model applied is also student-centered, so that they can be more active in the implementation of learning. As a syntax from the PBL model, this PBL-STEAM model is also ultimately shown from the results of their work, which was formed from an experience and understanding study.

STEAM learning is an approach that crosses disciplines of science that integrates five fields of science in the learning process. Approach: This is designed to grow innovation, creativity, and the ability to think like a student in designing results for their work as a solution to the given problem (Yakman, 2008). STEAM also emphasizes the importance of relatedness between disciplinary knowledge in the face of real-world problems in a holistic way. Integration of PBL with the STEAM approach in learning science, especially on the topic of environmental pollution, provides a big opportunity for students to understand scientific concepts in a meaningful way. Application of this model allows students not only to understand theoretical aspects of the polluted environment, but also to develop creative solutions based on technology, art, and mathematics. Research by Aini et al. (2022) integrated the STEAM model in a way that significantly increased results for students. This can help students grow interest, involvement, and skill levels.

In a polluted environment, students can be involved in projects or case studies related to air pollution, water pollution, or plastic waste, which pushes them to analyze causes, impacts, and look for innovative and applicable solutions. This is in line with the demands of the Independent Curriculum, which emphasizes learning based projects and strengthening the profile of Pancasila students. The learning outcomes in question cover cognitive, affective, and psychomotor skills. According to Bloom (1956), achievement results from optimal learning demands integration between knowledge, attitudes, and skills. Through the PBL-STEAM model, students are given the chance to understand concepts, show care for the environment, and apply science skills in real-life situations.

Study this in the form of a description implementation of the PBL-STEAM model, which is focused on increasing results for students on the material pollution environment. However, the review literature is required to show whether the study is still warm for review. Review literature done from various articles collected research through Publish or Perish with relevant keywords, and analyzed using VosViewer. The analysis results obtained are shown in Figure 1 as follows.

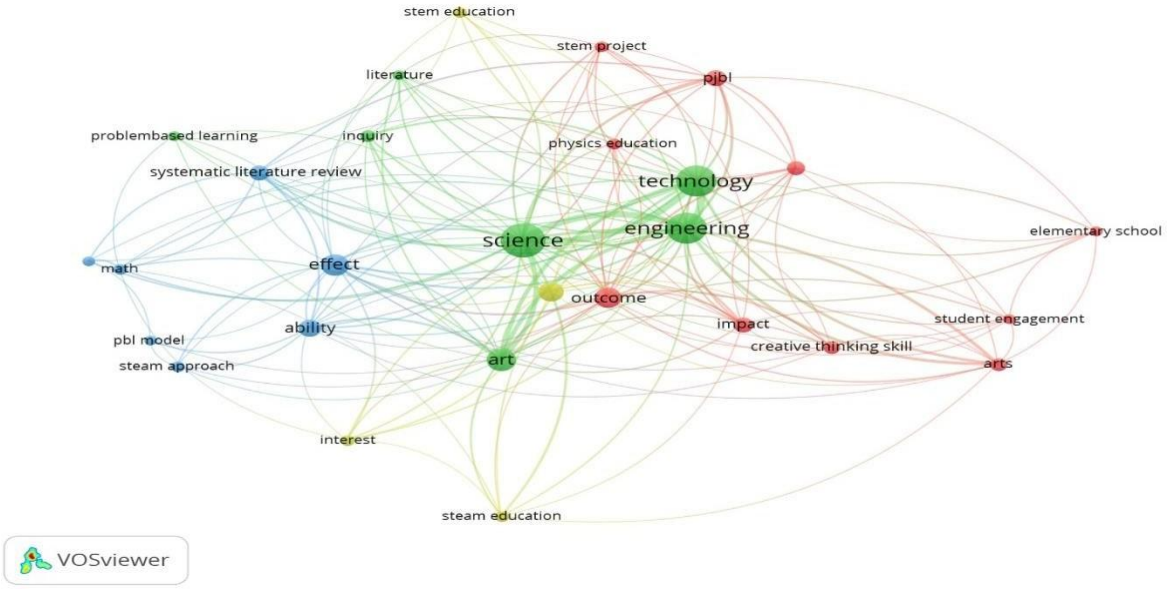


Figure 1. Analysis Bibliometrics Vos Viewers

In Figure 1, it is shown that the PBL model is still a hot topic for study and analysis over the last ten years, namely 2015-2025, from results search compiled articles Google Scholar via Publish or Perish 8, there are 200 most relevant articles. Analysis of keyword similarity, title, and abstract was done through Vos Viewers. 993 items were found and analyzed, so there are 28 items with 4 clusters. The results show that Science, Technology, Engineering, Art, and Mathematics (STEAM) is still a hot

topic for research. This was also stated by Suganda (2021) that studies about STEAM are still being investigated in the activity STEAM learning, which also tends to be reviewed from the outcome and its impact.

The PBL model in Figure 1 also shows relatedness with STEAM, so the PBL model is still warmly reviewed together with the STEAM approach. This explains that the PBL-STEAM model needs to be further reviewed to continue in determining outcomes and impacts in learning. Various Efforts need to be made to integrate PBL and STEAM models in environmental learning, particularly in relation to environmental pollution. This is to optimize the improvement of contextual learning outcomes and impact real life. The effect of the STEM- integrated PBL model on learning outcomes has been demonstrated in previous research (Andriani et al., 2024).

It was found that the implementation of the STEAM-integrated PBL model has an impact on student learning outcomes (Budiyono & Husna, 2020). The implementation of an appropriate learning model can encourage students' enthusiasm for learning and demonstrate optimal learning outcomes (Andriani & Rasto, 2019). This is due to the importance of learning motivation in improving student learning outcomes (Fernando et al., 2024), especially through the use of appropriate learning models. The PBL model can facilitate learning, especially in understanding concepts (Anggraini et al., 2024). Environmental pollution material needs to be studied extensively in real life (Hamidah et al., 2024).

Study This aim for analyzed the application of the PBL-STEAM model in improving student learning outcomes on environmental pollution material. Improving learning outcomes can be done by applying certain learning methods or learning models (Nasution, 2017). STEAM learning can improve student learning outcomes (Palennari & Fauziyah, 2024). The PBL model can also train students' critical thinking skills (Pertiwi et al., 2023). The implementation of STEAM also has the potential to have a positive influence on learning (Pudjiastuti et al., 2024). STEM can also improve critical and creative thinking skills (Rahmawati et al., 2022). Pollution material can be learned through the application of a cooperative learning model (Ramadhany & Martini, 2018).

The PBL model is one of the cooperative learning models that has the potential to improve student learning outcomes on environmental pollution material. The PBL model can be applied in learning to support in facing the challenges of the 21st century (Rizkamariana et al., 2019). The implementation of innovative learning models is necessary in sustainable development that impacts student skills (Rohmah & Lestari, 2024). The PBL-STEAM model is one of the innovative models that need to be implemented to improve the quality of learning. The PBL model can also train students' scientific abilities (Shofiya, 2018). This strengthens the need for PBL to be integrated with STEAM. Learning outcomes will be improved through active, creative, effective, and enjoyable learning (Somaya, 2020), which was also obtained from the implementation of the PBL-STEAM model observed in this study.

2. Method

Research methods: This is in the form of a quantitative descriptive study with a quasi- experimental design. Research: This uses a pretest-posttest control group design. Study. This involves class VIIA as class experiments, and class VIIB as class control. Class experiment is the class given treatment in the form of learning with the PBL-STEAM model, whereas class control is the class given treatment with normal learning applied in class, namely the PBL model. Research Pretest-Posttest Nonequivalent Control Group Design. According to Arikunto (2013), as presented in Table 1, the following.

Table 1. Research Design: Pretest-Posttest Nonequivalent Control Group Design

Class	Pre-Test	Treatment	Post Test
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

Information:
X_1 = Implementation of the STEAM-based PBL model
X_2 = Implementation of the PBL model
O_1 = Learning outcomes of students before implementation of the STEAM-based PBL model
O_3 = Learning outcomes of students after implementation of the STEAM-based PBL model
O_2 = Learning outcomes of students before implementation of the PBL model
O_4 = Learning outcomes of students after implementation of the PBL model

where an equation is defined as follows:
In research, the use of projectors as teaching tools makes it easier to deliver material in a pollution-free environment. Contents of the method study. There are a number of stages. At an early stage, students are given a pretest and delivery material. Middle delivery material, given an example problem to the student related to the STEAM approach. From the example, it can be seen that students can understand example-related issues with the STEAM approach. Next, students are given a sheet of Work as a form of practice to understand students. Research was conducted in Sambas Regency and Regency Stuffed precisely at the school medium, First class VII year 2025/2026 academic year.

Study this using the PBL-STEAM model and the PBL model, consisting of three main stages: preparation, implementation, and ending. At stage preparation, on-site observation research, and get permission from the party school to determine two classes as samples. Next, the curriculum was analyzed to determine material lessons to be learned taught. Discussion with science teachers held to understand the method of normal learning used. In addition, it is an instrument study in the form of a questionnaire sheet, Response Students, Observation Sheet, Activity Student Worksheet Student through question narrative, and worksheets for Students (pretest and posttest). After the instrument study was arranged, a validation of the research instruments was done. Next, after the instrument is declared valid and reliable, the implementation stage is done, which consists of one meeting.

Implementation evaluation learning this, namely with a method, involves a pretest in class experiments and controls with a double question choice. For measuring achievements, Study cognitive participants. Meeting This involves the learning process during three times with applying PBL-STEAM learning, such as giving example problems, students present problems that have been prepared, and students fill out the questionnaire. Response of students towards the PBL and PBL STEAM models in science learning. At the end of learning, a posttest is given to measure results. The Study of cognitive participants after learning. Stage end study involving data processing and analysis using statistical descriptive methods. Methods. For now, the implementation of the STEAM-integrated PBL model aims to increase results, Study cognitive participant education.

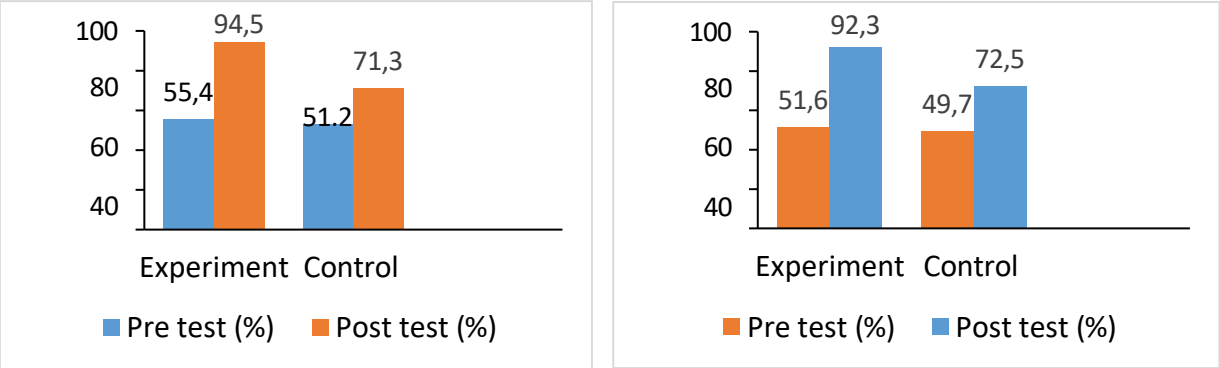
Data collected using a sheet test consisting of 10 customized questions with levels of cognitive Revised Bloom's Taxonomy from C1 to C6. Test This is designed to measure the cognitive ability of participants educated on sub-chapter science material, Pollution Environment. The test was carried out twice, namely before and after the Implementation of PBL-STEAM and PBL learning models. Data analysis techniques used to cover analysis statistics, descriptive statistics in the form of percentage scores, and calculations with the N- Gain formula (Hake, 1999), in equation (1) as follows.

$$< G >= \frac{Sposttest - Spretest}{Sideal - Spretest} \quad (1)$$

where:
<G> = Gain Score
$S_{posttest}$ = Test score end
$S_{pretest}$ = Test score beginning
S_{ideal} = Ideal score

3. Results and Discussion

This stydy was done in class experiments and class control on a sample, Research in Sambas and Bengkayang districts. Data from pretest and posttest results of students in the class control and experimentation on students in Sambas Regency in the study. This is shown in Figure 1 as follows.



(a) **(b)**

Figure 2. Percentage of Average Scores of Students' Pre-test and Post-test. (a) Sambas Regency (b) Sambas Regency Stuffed

In Figure 2, it is shown that the results of the class post-test scores experiments and classes control their own higher score than the pretest. However, the comparison results of the experiment with class control on the pretest and posttest results reveal that the class experiment is superior compared to the class control. This is due to the integration of the PBL-STEAM model having an effect on the results of the Study students (Wedanthi et al., 2025).

Through the N-Gain equation in formula (1), we found that the results N-Gain score of 0.66 or category currently implementing the PBL model, and the results N-Gain score of 0.71 or category tall through implementation of the PBL-STEAM model. This explains that the application of the PBL-STEAM model provides improvement results, learn more about the application of the PBL model to material pollution. Environmental materials can be implemented through integrated STEAM learning (Ramadhana et al., 2022).

Based on observations of the samples in this study, the indicators emerging from the application of the PBL-STEAM model to the research samples in Sambas Regency and Bengkayang Regency in this study were students' enthusiasm, interest, and activeness. Observations showed that these three categories had high percentage scores.

The results of this observation were strengthened by conducting interviews with students. Based on the results of the interview questionnaire in the form of student responses to the application of the PBL-STEAM model in this study. In Sambas Regency, it was found that students felt happy in participating in PBL-STEAM learning by 92% with a high category, students could easily follow the

learning by 83% with a high category, students felt enthusiastic in implementing STEAM learning. by 88% with a high category, students were willing to repeat learning through the application of the PBL-STEAM model by 90% with a high category, and students could easily master concepts through the application of the PBL-STEAM model by 87% with a high category. Similar things were also found in Bengkayang Regency, namely that 92% of students felt happy in participating in PBL-STEAM learning with a high category, 83% of students could easily follow the learning with a high category, 88% of students felt enthusiastic in implementing STEAM learning with a high category, 90% of students wanted to repeat the learning through the application of the PBL-STEAM model with a high category, and 87% of students could easily master the concept through the application of the PBL- STEAM model with a high category.

Thus, the application of the PBL model is recommended. In implementation, learning can give results. Study the pollution environment with Good Because students can understand the draft through real experience, and understanding is attributed to life daily with an approach that involves various cross-disciplinary science (STEAM) from various given problems (PBL).

4. Conclusion

The application of the PBL-STEAM model can improve student learning outcomes on environmental pollution material in the high category. Election between the PBL-STEAM and PBL models can be customized with the needs of learning, characteristics of students, and the environment learning. The PBL-STEAM model is expected to also be applied to other materials.

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