Indonesian Journal of
Mathematics and Natural Sciences Education
p-ISSN: 2721-172X e-ISSN: 2721-1746
Vol. 6 No. 2 Th 2025; Hal 96-101
http://mass.uinkhas.ac.id DOI: 10.35719/mass.v6i2.221

# Implementation of Smart Box Media in Problem-Based Learning to Improve Students' Scientific Literacy on Environmental Pollution

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**Abstract**

This study aims to improve students' scientific literacy by applying the Problem-Based Learning (PBL) model assisted by smart box media on environmental pollution material. This study uses a pre-experimental method with a one-group pre-test post-test design and purposive sampling. The data analysis techniques applied in this study are hypothesis testing using paired sample t-test, n-gain test, and product moment correlation. The results showed that the implementation of learning was 89.67% which was included in the very good category, paired sample t-test was 0.000. And strengthened by the n-gain test of 0.59 with a moderate category and the correlation between student learning outcomes and scientific literacy showed a significance value of 0.420 in the moderate correlation category. The conclusion of this study is that the PBL model assisted by Smart Box media has an effect on students' scientific literacy which can increase significantly from their initial level, and there is a relationship between student learning outcomes using the PBL model assisted by smart box media and scientific literacy.

**Key words**: Environmental Pollution, Problem Based learning, Smart Box, Scientific Literacy.

## INTRODUCTION

Entering the 21st century, students are expected to possess the ability to face and solve various problems in everyday life, both related to natural and social phenomena. These skills can be nurtured through the learning of Natural and Social Sciences (IPAS), where students are not only required to understand theoretical concepts but also to connect them to real-life situations and their surrounding environment (Khotimah, 2020).

However, based on preliminary observations and interviews, several issues have been identified in the learning process of IPAS, particularly in Grade X at SMK Negeri 1 Lamongan. One of the main problems is the suboptimal use of learning media, especially in the topic of environmental pollution. Teachers tend to rely on lecture-based methods, which make the learning process passive. Observations revealed that only around 25% of students paid attention and responded during lessons. Consequently, student achievement is also relatively low, with only 65% of students meeting the Learning Objectives Achievement Criteria (KKTP), whereas the school's standard KKTP is set at 70–75%.

Furthermore, interview results showed that although some teachers attempted to implement the Problem-Based Learning (PBL) model, only around 40% were able to do so. The main challenges were difficulties in identifying relevant problems and the lack of student curiosity, resulting in



DOI: https://doi.org/10.35719/mass.v6i2.221

ineffective PBL implementation.

Science plays a crucial role in education by helping students develop critical, logical, creative, and innovative thinking skills. Therefore, scientific literacy is essential. Scientific literacy goes beyond understanding theories; it involves the ability to identify real-world problems, use scientific evidence, and make informed decisions related to nature and human-induced changes (Sutisna, 2021).

Unfortunately, Indonesian students still show low levels of scientific literacy. According to the Programme for International Student Assessment (PISA) survey, from 2012 to 2018, Indonesia ranked 74th out of 79 countries—placing it sixth from the bottom in terms of science literacy among 15-year-old students (Kemendikbud, 2019).

One potential solution to this issue is integrating the Problem-Based Learning model with engaging and interactive media, such as the Smart Box. According to the NEA (as cited in Nurfadhilah, 2021), learning media includes anything that can be seen, read, heard, discussed, or manipulated by students. Smart Box is an interactive learning tool that has been shown to enhance student focus and engagement (Annisa, 2018). However, preliminary findings indicated that this media has never been used in classroom instruction.

Previous studies have explored the use of PBL to enhance scientific literacy, but the novelty of this study lies in the application of Smart Box as a supporting media and the specific focus on vocational high school (SMK) students—a group that has rarely been the subject of such research in this context.

Based on the issues outlined above, it can be concluded that low scientific literacy and lack of student interest are major concerns. Therefore, this study aims to investigate the implementation of the Problem-Based Learning model assisted by Smart Box media to improve students' scientific literacy in the topic of environmental pollution.

## METHOD

This study conducted in experimental method, specifically a Pre-Experimental Design using the One-Group Pretest–Posttest Design. The research was conducted during the even semester of the 2022/2023 academic year. The following table shows the pretest-treatment/treatment–posttest design.

**Table. 1 Table 3.1 Pretest, treatment, posttest design.**

| Pre-test | Treatment | Post-test |
|---|---|---|
| $X_1$ | Y | $X_2$ |

The population of this study consisted of all students at SMK Negeri 1 Lamongan. The sampling technique used was purposive sampling, with the sample being Class X Visual Communication Design (DKV) 1, which served as the experimental class.

The research process was divided into three general stages:

1. Preparation stage
2. Implementation stage
3. Final stage

The instrument used in this study was a test consisting of both pretest and posttest items. All test instruments were analyzed for validity before use. The data collection technique utilized was a test technique, aiming to measure the effect of the Problem-Based Learning model assisted by Smart Box media on students' scientific literacy.

For data analysis, statistical methods were applied, including:

1. Normality test
2. Homogeneity test
3. Hypothesis testing using the paired sample t-test
4. N-gain test to measure the effectiveness of the treatment.

## RESULT AND DISCISSION

The normality of the pretest and posttest results was assessed using the Shapiro-Wilk test, which is appropriate for sample sizes between 50 and 100 (Handy, P., 2017). The analysis was conducted through the *Explore* function, using the significance values in the Shapiro-Wilk column. According to the statistical rule, if the significance value (Sig.) > 0.05, the data is considered to be normally distributed; conversely, if Sig. < 0.05, the data is not normally distributed. Based on the Shapiro-Wilk table:

1. The posttest cognitive data for the experimental class showed significance values of 0.071 and 0.058, indicating normal distribution.
2. The posttest scientific literacy data showed significance values of 0.076 and 0.075, also indicating normal distribution.

Since the data were normally distributed, further analysis used parametric statistical methods.

N-Gain test was conducted to measure the improvement in students' scientific literacy. The N-Gain (Normalized Gain) is used to determine the level of learning improvement before and after instruction (Sundayana, R., 2014). This test supports the results of the paired sample t-test.

From the results:

1. The average pretest score in Class A1 was 52.05, and in Class A2, 52.91.
2. The average gain score was 29.03 for Class A1 and 28.91 for Class A2.
3. The N-Gain value for Class A1 was 0.59, and for Class A2 0.60 — both fall into the moderate category of improvement.

In addition, the N-Gain was also calculated based on each of the five scientific literacy indicators. The diagram (not shown here) indicates that all five indicators improved after the intervention:

1. Identifying, using, and generating clear models and representations (Pretest average: 51, Posttest average: 83)
2. Making and justifying appropriate predictions (Pretest average: 50, Posttest average: 78)
3. Explaining the potential implications of scientific knowledge for society (Pretest average: 61, Posttest average: 76)
4. Analyzing data across different representations (Pretest average: 49, Posttest average: 85)


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5. Proposing scientifically sound methods to explore given questions (Pretest average: 57, Posttest average: 85)

To test the hypothesis, the paired sample t-test was used. The decision criteria are as follows:

1. If the significance level (Sig. 2-tailed) > 0.05, then $H_0$ is accepted and $H_a$ is rejected, indicating no significant effect.
2. If the Sig. < 0.05, then $H_a$ is accepted and $H_0$ is rejected, indicating a significant effect.

The result of the paired sample t-test showed a significance value of 0.000, which is less than 0.05. Therefore, $H_a$ is accepted, and it can be concluded that:

There is a significant effect of the Problem-Based Learning (PBL) model assisted by Smart Box media on students' scientific literacy.

Based on the data, the significance value from the paired sample t-test was 0.000, which is less than 0.05. This indicates that $H_a$ is accepted and $H_0$ is rejected, meaning there is a significant effect of the Problem-Based Learning (PBL) model assisted by Smart Box media on students' scientific literacy in the topic of environmental pollution.

The pre-test literacy score for Class A1 and Class A2 was 52.48, indicating that students' initial scientific literacy skills were quite similar. After receiving the learning intervention, the second class showed improvement in scientific literacy and cognitive understanding. The average post-test score increased to 80.99, representing a 28.97-point increase, which falls into the moderate improvement category.

The Problem-Based Learning (PBL) model has a positive effect because, during the learning process, students are asked to collaboratively solve problems through Student Worksheets (LKPD) and reflect on the results of their discussions. Furthermore, they conduct simple experiments that connect scientific concepts to real-life problems, enabling them to accurately complete tasks based on the researcher's process.

Similar findings have been reported in other studies. For example, D.N.A. Sari (2020) concluded that the use of a problem-based learning model has a positive effect on students' scientific literacy. Students taught through PBL (Problem-Based Learning) with the aid of Smart Box media demonstrated higher scientific literacy skills than students taught through traditional lecture methods combined with conventional experiments and standard teaching materials commonly used in schools.

Previous research has shown that student activity in the classroom is supported by effective learning implementation. Therefore, the impact of improved student learning outcomes is also influenced by the implementation of learning (Rohmawati, 2018). Therefore, excellent learning implementation can increase student activity during learning.

Student activity in learning using the Problem-Based Learning model achieved an implementation percentage of 100%, with an achievement score of 97.56%. The results of this study indicate

a positive and significant influence of the relationship between the implementation of learning in science and the PBL model. This means that if the implementation of learning using the PBL model is high, students' scientific literacy skills are also high (Rina, 2020). Excellent learning implementation can be concluded that students enjoy learning using the PBL learning model, with an overall average percentage of 90%.

## CONCLUSION

Based on the correlation test aimed to determine the relationship between learning outcomes using the problem-based learning model assisted by smart box media with students' scientific literacy with the results of sig (2-tailed) the significance value is 0.000 <0.05, then there is a relationship between scientific literacy and the PBL model. With the level of closeness of the relationship from the Pearson correlation value of 0.420 which means getting a relationship with the medium category.

Based on the results of the hypothesis test, there is a significant effect of the Problem-Based Learning (PBL) model assisted by Smart Box media on students' scientific literacy in the topic of environmental pollution, with a significance value from the paired sample t-test of 0.000 < 0.05.

This significant effect is further supported by the N-gain results in scientific literacy:

1. Class A1 obtained an N-gain score of 0.59
2. Class A2 obtained an N-gain score of 0.60

Both scores fall into the moderate category of improvement. In terms of cognitive learning outcomes, the N-gain score was 0.59 for both Class A and Class B, also categorized as moderate

These findings indicate that the PBL model, when supported by Smart Box media, effectively enhances both scientific literacy and cognitive learning outcomes of students.

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