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Article

The Effectiveness of the Problem-Based Learning (PBL) Model with an Education for Sustainable Development (ESD) Approach in Improving Students' Environmental Awareness

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ABSTRACT

The environmental awareness of students at SMPN 3 Ponorogo is still lacking as evidenced by results of initial observations through a pretest in class VII with material Ecology and Biodiversity in Indonesia, especially sub-chapter Influence of Human Actions on Environment, obtained an average of 48,83%. This study aims to determine the effectiveness of PBL model with ESD approach to environmental care skills of class VII students. The method used in this study is a quantitative approach with a True Experiment design with experimental and control classes. The sampling technique used is Simple Random Sampling, the sample is students of class VII B and VII F, each class consisting of 30 children. Data collection techniques with tests through pretest and posttest. Data analysis techniques used included normality tests, homogeneity, t-test (independent), N-Gain, and effect cohend. Based on the research results, it is known that the average value of experimental class' environmental care ability for environmental insight indicator is 80 to 90, the maintenance, preservation, and skills indicator is 90 to 98. PBL learning model and ESD approach proved effective in terms of environmental care skills as evidenced by the results of t-test (independent) which showed in experimental class and control class. The results of the N-Gain and effect cohend tests showed that experimental class was more effective in improving students' environmental care skills than control class.

INTRODUCTION

Education is a very important step that must be taken in developing a person's attitude, character, and personality. Education can be carried out within the family and formally (at school/madrasah). Natural Sciences (IPA) education is a science that discusses the application of events in everyday life, such as phenomena, natural components, and environmental issues (Hidayati, 2020). As it develops, science education is closely related to environmental issues, so a generation that is aware of environmental concerns is needed. Therefore, science education that implements sustainable development can encourage the formation of character in junior high school students in the form of concern for environmental issues (Jegstad & Sinnes, 2015)

The problem of low environmental awareness occurs at SMPN 3 Ponorogo. Students' environmental awareness was found in the initial observation data through tests to be still in the low category at only 48.83 percent. This is because many students still litter under tables, in front of classrooms, in the yard, and in rivers around the school. The pollution problem is becoming more serious as the amount of waste continues to increase, resulting in low environmental awareness (Bobulski & Kubanek, 2021). Also, science learning in schools still mostly uses lectures and classroom discussions, and rarely connects to environmental issues or problems. To deal with this, we need new learning models that teachers haven't used yet and that can be linked to environmental pollution issues, like Problem Based Learning.

The Problem-Based Learning model can be a solution because it encourages students to solve real-world problems or issues with a better understanding of science material and its application in everyday life (Ali & Ashmawy, 2019). Students' environmental awareness can be improved through the use of the PBL model and linked to real phenomena and issues found in the environment in science learning (Riyansyah & Masturi, 2023). In addition, the PBL model is more student-centered so that it can improve learning skills including collaboration, synthesis, communication, and problem solving (Jansson et al., 2015). The PBL model has five phases, namely orienting, organizing, guiding inquiry, developing and presenting results, and analyzing/evaluating (Johnson & Johnson, 1984). The application of the PBL model in learning can be supported by the Education for Sustainable Development approach.

Learning with an Education for Sustainable Development approach through outdoor learning methods that enable students to analyze and discuss issues with their peers is one way to address and prevent environmental problems in a sustainable manner. This is supported by previous research which states that science learning using the STM model and ESD approach can increase students' environmental awareness (Rahmah et al., 2021). Science learning through the ESD approach can improve students' environmental awareness for environmental sustainability in sustainable development, so that it can be utilized by future generations (Khoiri et al., 2023).

The Problem-Based Learning model with the Education for Sustainable Development approach is a learning method that combines material with real-world problems or issues based on direct investigation in the environment around the school and students' homes, thereby improving environmental awareness, increasing learning motivation, encouraging students to be active, and solving environmental problems in the surrounding area. Therefore, these models and approaches can work together to improve students' environmental awareness.

METHODS

The type of research used was quantitative research with the True Experiment method involving two groups with a random sample (Simple Random Sampling). The research was conducted at a school in Ponorogo City, namely SMPN 3 Ponorogo, located at Jl. MT. Haryono Gg. IV No.26, Beduri, Kec. Ponorogo, Kabupaten Ponorogo. The research lasted for 5 days, starting from February 10 to 14, 2025. The sample consisted of 60 students, namely VII B (experimental) and VII F (control). The indicators of a person's environmental awareness include knowledge in the form of environmental insight, attitudes in the form of care and preservation, and skills (Pratiwi & Hanin, 2023; Stapp & COX, 1974). The design used was a pretest-posttest involving two classes. The pretest was conducted before implementing the PBL model with an ESD approach, while the posttest was conducted after implementing the treatment. The research design can be seen in Table 1.

Table 1. True Exsperiment Research Design

Experimental Group	O_1 *Pretest*	X Treatment	O_2 *Posttest*
Control Group	O_1 *Pretest*	Y Treatment	O_2 *Posttest*

Description:
O_1 : *Pretest*
O_2 : *Posttest*
X : PBL model treatment with ESD approach
Y : Conventional model with lecture method

Data collection through observation, tests, and documentation. Observations were conducted to determine the level of students' environmental awareness, while tests were conducted through pre-tests and post-tests. Documentation was used to determine the activities of students and teachers during learning. The research instruments used were experimental and control class modules, multiple-choice questions (environmental awareness indicators), and socio-emotional questions (indicators of care, preservation, and skills). The research procedures were carried out as shown in Figure 1 (Kusumastuti et al., 2020; Saputra et al., 2021).

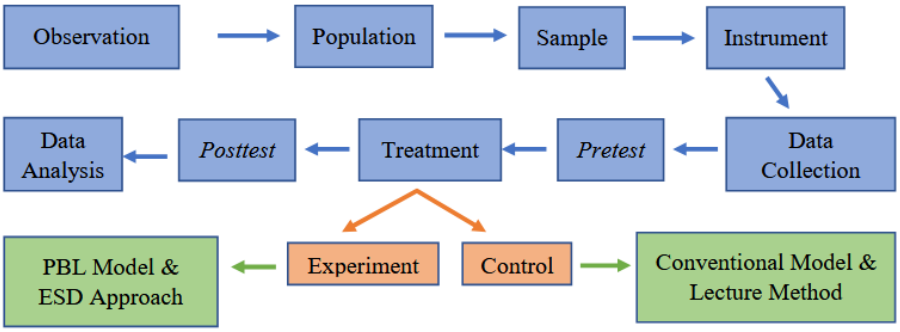


Figure 1. Quantitative Research Procedure True Experiment

The data analysis used was a prerequisite test covering normality (Kolmogorov-Smirnov, Shapiro-Wilk) and homogeneity using SPSS 27 for Windows software. A sig value >0.05 means that the data can be said to be normal and homogeneous, while a sig value < 0.05 means that the data is neither normal nor homogeneous. After the prerequisite tests were met, hypothesis testing was conducted using the Independent t-test through Minitab Statistical Software 22 for Windows, the N-Gain test, and the Cohen's effect test using SPSS 27 for Windows software. Conclusions can be drawn based on the significance values and the following conditions: If the t-test sig value is >0.05, then accept Ho, and if the t-test sig value is ≤0.05, then reject Ho. Ho is that there is no difference between the PBL model and the ESD approach. Ha: there is a difference between the PBL model and the ESD approach. The categories of N-Gain Percentage effectiveness (Hake, 1998) are shown in Table 2, while the criteria for the effect size (Rahmandani et al., 2022) can be seen in Table 3.

Table 2. N-Gain Effectiveness Categories

Value N-Gain (%)	**Kategori**
> 76	Very Efektif
56 – 75	Quite Efektif
40 – 55	Less Efektif
< 40	Not Efektif

Table 3. Effect Cohend Value Criteria

Value *Effect Cohend*	**Kategori**
0,2 – 0,4	Minor Effect
0,5 – 0,8	Medium Effect
0,9 – 1,3	Large Effect
>1,3	Very Large Effect

RESULTS AND DISCUSSION

Based on the results of the study, it was found that the environmental awareness of students using the Problem-Based Learning model with the Education for Sustainable Development approach was higher than that of students in classes that used the conventional lecture method. Significant differences were observed not only in terms of understanding of environmental awareness but also in terms of the more active participation of students in the experimental class compared to the control class. The highest environmental awareness score was obtained by the experimental class that had implemented the PBL model with the ESD approach, which was 90. The highest scores for the indicators of conservation, preservation, and skills also came from the experimental class that had implemented the PBL model with the ESD approach (posttest), namely 98. The minimum, maximum, average, and standard deviation scores can be seen in Figure 2 for the environmental awareness indicator and Figure 3 for the conservation, preservation, and skills indicators.

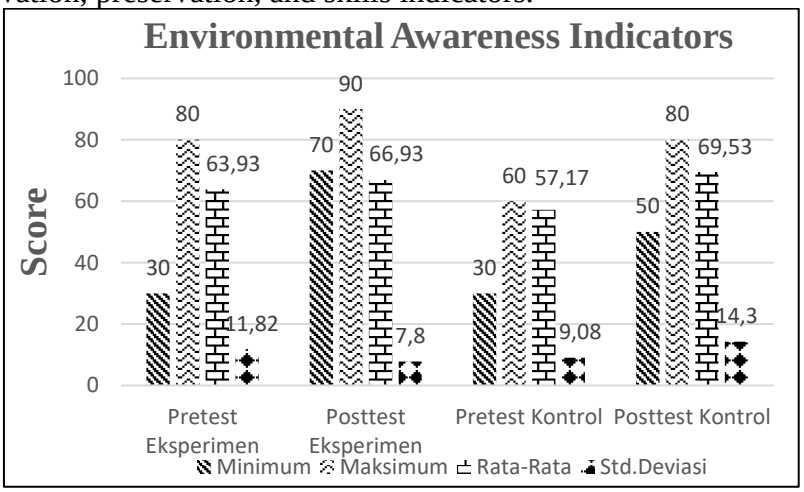


Figure 2. Environmental Awareness Indicator Score

Based on the data in Figure 2, it can be seen that the environmental awareness indicator for the experimental class had a minimum pretest and posttest score of 30 and 70, respectively, while the maximum scores were 80 and 90 points. In the control class, the minimum pretest score was 30 and the posttest score was 50, while the maximum scores were 60 and 80. The average pretest and posttest scores obtained in the experimental class were 63.93 and 66.93, while the control class had a pretest score of 57.17 and a posttest score of 69.53. The standard deviation obtained in the experimental class for the pretest and posttest scores was 11.82 and 7.80, while in the control class it was 9.08 and 14.30.

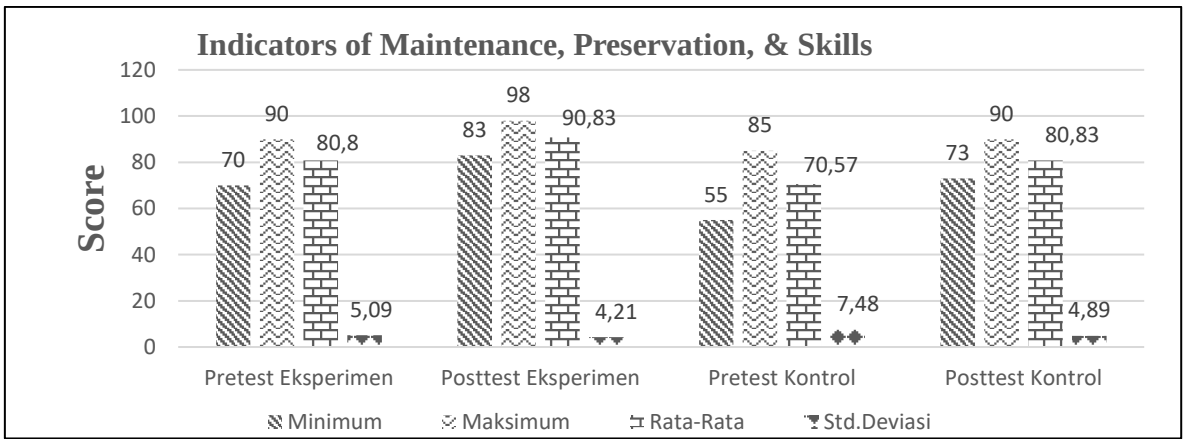


Figure 3. Score for Indicators of Maintenance, Preservation, and Skills

Based on the data in Figure 3, it can be seen that the indicators of maintenance, preservation, and skills in the experimental pretest class had a minimum value of 70, a maximum of 90, an average of 80.80, and a standard deviation of 5.09. The experimental posttest class had a minimum value of 83, a maximum of 98, an average of 90.83, and a standard deviation of 4.21. Meanwhile, the control pretest class had a minimum score of 55, a maximum score of 85, an average score of 70.57, and a standard deviation of 7.48. The control posttest class had a minimum score of 73, a maximum score of 90, an average score of 80.83, and a standard deviation of 4.89. Based on the highest score of 90 for the environmental awareness indicator and 98 for the indicators of care, preservation, and skills, both of which were achieved in the posttest experimental class, it can be concluded that students experienced an increase in their environmental awareness, care, preservation, and skills related to the material.

The hypothesis of this study is to examine the effectiveness of the Problem-Based Learning model with an Education for Sustainable Development approach on the environmental awareness of students at SMPN 3 Ponorogo. Hypothesis testing can be carried out if the prerequisites or assumptions are met. The assumptions tested are normality and homogeneity. The results of the normality test for environmental awareness indicators are shown in Table 4, while those for the indicators of preservation, conservation, and skills are shown in Table 5.

Table 4. Results of the Normality Test for Environmental Awareness Indicators

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	**Statistic**	**Df**	**Sig.**	**Statistic**	**df**	**Sig.**
Environmental awareness skills	Eksperimen	.277	30	.113	.771	30	.118
	Kontrol	.226	30	.089	.868	30	.078

a. Lilliefors Significance Correction

Based on the results in Table 4, the Kolmogorov-Smirnov test showed Sig values of 0.113 and 0.089, while the Shapiro-Wilk test showed Sig values of 0.118 and 0.078. The results show a significance value of more than 0.05, so it can be said that the data from the environmental awareness indicators in the experimental and control classes are normally distributed.

Table 5. Results of the Normality Test for the Indicators of Care, Preservation, and Skills

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	**Statistic**	**Df**	**Sig.**	**Statistic**	**df**	**Sig.**
Environmental awareness skills	Eksperimen	.242	30	.089	.898	30	.077
	Kontrol	.152	30	.075	.946	30	.136

a. Lilliefors Significance Correction

Based on the results in Table 5, the Kolmogorov-Smirnov test shows Sig values (0.089 and 0.075) and the Shapiro-Wilk test shows Sig values (0.077 and 0.136). The results show that the significance value is greater than 0.05, so it can be concluded that the indicators of maintenance, preservation, and skills in the experimental and control classes are normally distributed. The data can be further tested for homogeneity. The results of the homogeneity test for environmental awareness indicators are shown in Table 6, while the indicators of maintenance, preservation, and skills are shown in Table 7.

Table 6. Results of the Homogeneity Test for Environmental Awareness Indicators

Tests of Homogeneity of Variances

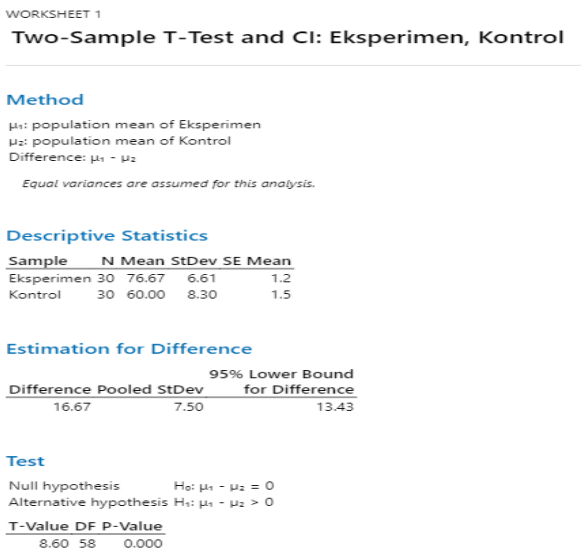
		Levene Statistic	df1	df2	Sig.
Environmental awareness skills	Based on Mean	1.413	1	58	.239
	Based on Median	.853	1	58	.360
	Based on Median and with adjusted df	.853	1	56.248	.360
	Based on trimmed mean	1.002	1	58	.321

Table 7. Results of the Homogeneity Test for Indicators of Environmental Care, Preservation, and Skills

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Environmental awareness skills	Based on Mean	4.375	1	58	.067
	Based on Median	4.003	1	58	.070
	Based on Median and with adjusted df	4.003	1	57.750	.070
	Based on trimmed mean	4.535	1	58	.057

Based on the data in Table 6, the significance value for the environmental awareness indicator is 0.239. In Table 7, the significance value for the indicators of maintenance, preservation, and skills is 0.067. Both data show that the significance value is greater than 0.05. The data can be concluded to be homogeneous. The assumption test has been fulfilled, so the data can be used for hypothesis testing. Two hypothesis tests were used, namely the T-test and the N-gain test. The following are the results of the hypothesis testing. The results for the knowledge indicator are shown in Figure 4, while the results for the attitude and skill indicators are shown in Figure 6. The average results for environmental awareness as an environmental awareness indicator are shown in Figure 5, while the results for the indicators of care, preservation, and skills are shown in Table 7.


WORKSHEET 1

Two-Sample T-Test and CI: Eksperimen, Kontrol

Method

μ_1: population mean of Eksperimen
μ_2: population mean of Kontrol
Difference: $\mu_1 - \mu_2$

Equal variances are assumed for this analysis.

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Eksperimen	30	76.67	6.61	1.2
Kontrol	30	60.00	8.30	1.5

Estimation for Difference

Difference	Pooled StDev	95% Lower Bound for Difference
16.67	7.50	13.43

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis $H_1: \mu_1 - \mu_2 > 0$

T-Value	DF	P-Value
8.60	58	0.000

Figure 4. Results of the Independent Sample t-test for Environmental Awareness Indicators Using Minitab 22

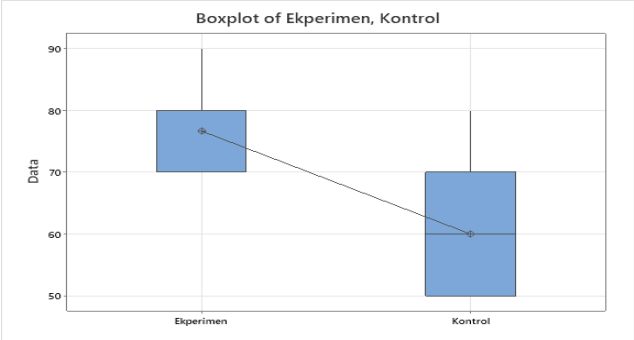


Figure 5. Average Environmental Awareness Indicators

WORKSHEET 1

Two-Sample T-Test and CI: Eksperimen, Kontrol

Method

μ₁: population mean of Eksperimen
μ₂: population mean of Kontrol
Difference: μ₁ - μ₂

Equal variances are assumed for this analysis.

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
Eksperimen	30	88.70	3.68	0.67
Kontrol	30	80.83	4.89	0.89

Estimation for Difference

Difference	Pooled StDev	95% Lower Bound for Difference
7.87	4.33	6.00

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis $H_1: \mu_1 - \mu_2 > 0$

T-Value	DF	P-Value
7.04	58	0.000

Figure 6. Results of the Independent Sample t-test for the indicators of maintenance, preservation, and skills using Minitab Version 22

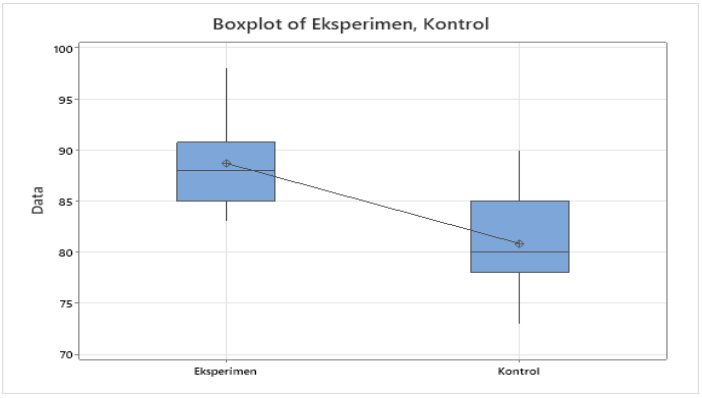


Figure 7. Average environmental awareness scores for the indicators of maintenance, preservation, and skills

Based on the P-Value results in Figures 4 and 6, the value obtained was 0.000, which is less than 0.05. The data shows that there is a difference in environmental awareness between the PBL model and ESD approach and the conventional model in science lessons for Grade VII students at SMPN 3 Ponorogo. The indicators of maintenance, preservation, and skills show that there is a difference in environmental awareness between the experimental class and the control class. Based on Figure 5, the environmental awareness indicator is at an average of 70-80 because students are not interested in reading the questions, so their literacy is still low. The reading comprehension questions are found in several multiple-choice questions. The passages are in the form of news about the causes, impacts, and solutions to environmental problems, types of waste, and the time required for inorganic waste to decompose. The relationship between reading and environmental awareness indicators is that when students feel

lazy to read, their environmental awareness will be low because they do not understand the material provided, and their environmental awareness skills will be low (Sumanik et al., 2021). One of the obstacles in improving environmental awareness is low knowledge (Adawiah, 2020). Environmental awareness requires knowledge about waste management, preservation, and processing (Pratiwi & Hanin, 2023). Environmental awareness indicators connected to PBL syntax include the organizing stage, where students read material about the impact of human actions on the environment (Muna & Darsono, 2023). The stage of developing and presenting results is linked to one of the principles of ESD, namely critical thinking in the form of knowledge acquired by students when they learn and write down their understanding of the causes, impacts, and solutions to environmental problems in their worksheets (Vioreza et al., 2023).

Based on Figure 7, the indicators of preservation and skills in the experimental class were at an average of 85-95, which was higher than the environmental awareness indicators. This was because students were able to answer questions well through their understanding of environmental pollution caused by human actions. Students can understand and find solutions to reduce and overcome problems, such as turning inorganic waste into crafts and organic waste into compost or organic fertilizer. The indicators of care, preservation, and skills in environmental awareness can be measured through the ability to maintain cleanliness, preserve the environment, and process waste (Stapp & COX, 1974). The indicators of maintaining, preserving, and skills are connected to the PBL syntax at the orientation stage, which is linked to the ESD principle of interconnection, including direct observation of the environment around the school so that students can determine the actions to be taken. Other PBL stages connected to attitude and skill indicators include the guided investigation stage, where students conduct direct observations of the environment chosen together with their group (Sukorini & Purnomo, 2019). The stage of developing and presenting results related to ESD principles, namely participation, involves students discussing and working together to complete worksheets, and value-based principles, namely students processing inorganic waste into simple crafts (Filho et al., 2015). The stages of analyzing and evaluating are linked to the ESD principle of experience-based learning, which is also connected to attitude and skill indicators because students apply their experiences in learning that can be applied in everyday life (Susanti et al., 2024).

The factor with the highest experimental class score in each indicator, namely the PBL model and ESD approach, requires students to be active in finding the causes, impacts, and solutions to environmental problems (Az-zarkasyi & Hindun, 2024). Learning conducted through direct observation of the environment experiencing problems encourages students' thinking process so that more material is understood. According to Shannon L. Navy, Jennifer L. Maeng, Randy L. Bell, and Fatma Kaya in their research, problem-based learning and investigation using the PBL model can improve the ability to understand material so that it can be applied in everyday life (Navy et al., 2021). The PBL model can encourage students to solve problems through group discussions, such as environmental issues. In line with previous research conducted by Dwi and Wahyu, students' environmental awareness can change through PBL learning. This is because the PBL model is related to issues in daily life, such as environmental issues, so that it can train students to find causes, impacts, and solutions in problem solving (Handayani & Sopandi, 2015). Learning in the experimental class was also linked to the ESD approach to improve environmental awareness.

ESD-based learning has principles that encourage students to develop an environmentally conscious attitude that is applied in their daily lives through the understanding gained from learning materials such as science (Filho et al., 2015). Learning activities conducted outside the classroom, such as observing environmental issues around the school, can encourage awareness of the need to protect and preserve the environment so that future generations can still use the environment wisely (Sajidan et al., 2022). In line with the research by Kirsti and Astrid, learning with an ESD approach by linking environmental issues can

increase awareness in protecting and preserving the environment (Jegstad & Sinnes, 2015). The results of the effect cohend value can be seen in Figure 8.

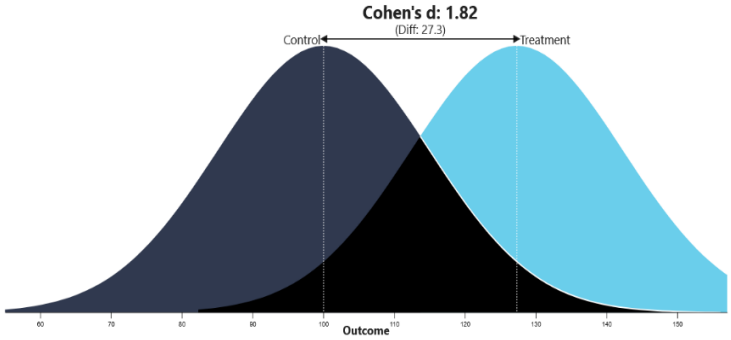


Figure 8. Results of the Cohend Effect Test for the Experimental and Control Classes

Based on Figure 8, it can be seen that a cohend value of 1.82 indicates a very large difference between the experimental and control groups. The results show that 96.6% of students in the experimental class had a higher average score than those in the control class. The average score overlap or similarity between students in the experimental and control classes was 36.3%. The results show that learning using the PBL model and ESD approach is more appropriate than conventional models and lecture methods for improving environmental awareness. The results of the N-gain test for the environmental awareness indicator are shown in Figure 9, and the indicators for maintaining, preserving, and skills are shown in Figure 10.

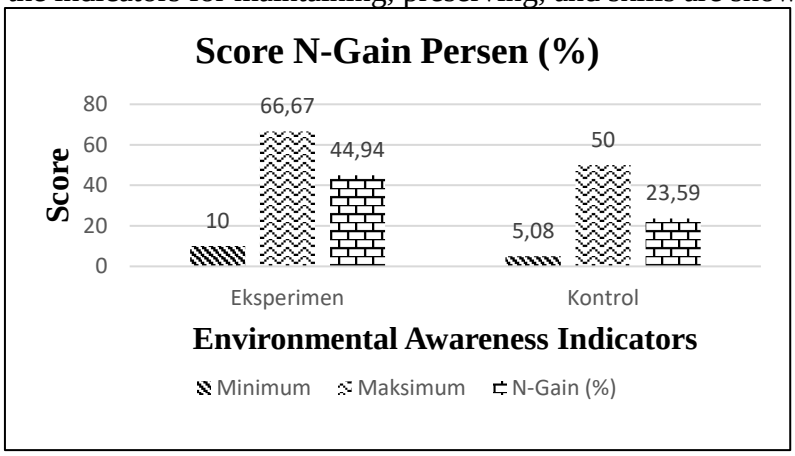


Figure 9. Results of the N-Gain Test Percentage (%) of Environmental Awareness Ability on Environmental Awareness Indicators

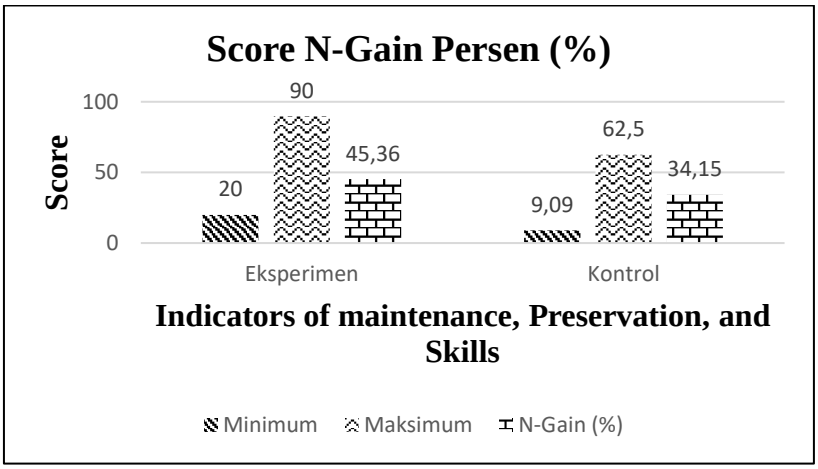


Figure 10. Results of the N-Gain Test Percentage (%) of Environmental Awareness on the Indicators of Maintenance, Preservation, and Skills

Based on the results in Figure 9, for the environmental awareness indicator, the experimental class with the PBL model and ESD approach had an average N-gain percentage of 44.94% with a minimum of 00.00 and a maximum of 66.67. The control class with the conventional model and lecture method had an average value of 23.59% with a minimum of 00.00 and a maximum of 50.00. Based on the results in Figure 10, the N-gain percentage value for the indicators of maintenance, preservation, and skills for the experimental class obtained an average of 45.36% with a minimum of 20.00 and a maximum of 90.00. The control class had an average N-gain percentage of 34.15% with a minimum of 9.09 and a maximum of 62.50. Based on the N-gain test results in the experimental class, both the environmental awareness and maintenance, preservation, and skills indicators were categorized as ineffective with percentages of 44.94% and 45.36%. The control class was found to be ineffective because the percentage values were less than 40%, namely 23.59% and 34.15%. The PBL model with an ESD approach was ineffective in science learning in grade VII at SMPN 3 Ponorogo in improving environmental awareness. Ineffective means that it can improve environmental awareness but not significantly.

The PBL model with an ESD approach is said to be less effective because seventh-grade students more often follow conventional learning models, so the implementation of the PBL model and ESD approach requires more time. Learning that only uses the conventional model has effects on students, including passivity (because it is teacher-centered), monotony, which leads to laziness and boredom, drowsiness, and students only learning individually (Niak et al., 2018). Learning that applies the conventional model, the educator is the center of information and students only have to listen to the information that is transferred so that it can give rise to feelings of boredom and saturation which will certainly have an impact on the level of understanding obtained (Sulastri & Pertiwi, 2020). So the PBL model is an alternative that can be used by teachers to create active and enjoyable learning so that students gain a deeper understanding to solve problems around them, for example environmental issues (Nailatun et al., 2024). Seventh-grade students at SMPN 3 Ponorogo did experience an increase in environmental awareness, although it was not significant. This was because there were still some students who did not apply what they had learned in their daily lives, such as throwing trash out of the window, resulting in pollution in the school's backyard. Seventh-grade students were aware of environmental issues only during the learning process, but most students already had environmental awareness skills.

According to research by Atikah, Wirawan, Rahmi, Titah, and Ulinnuha, the ESD approach can increase environmental awareness as seen from attitude indicators, namely littering and reforestation (Rahmah et al., 2021). Learning associated with the ESD approach can increase environmental awareness, although not significantly. Seventh-grade students at SMPN 3 Ponorogo have applied the principles of the ESD approach in an experimental class in learning to make projects by processing waste into crafts so that they can be reused. The ESD approach that actively involves students in the learning process by linking them to values of care can encourage their awareness, such as being able to solve problems regarding environmental issues that occur around them, so that a sense of responsibility in protecting nature will grow within them to maintain the continuity of sustainable life that can be utilized or used by future generations (Sihombing et al., 2024).

The ESD principles related to learning include interconnection, participation, critical thinking, value-based, and experience-based learning (Filho et al., 2015). According to Irmeli Palmberg, Ida Berg, Eila Jeronen, Sirpa Karkkainen, Pia Norrgard Sillanpaa, Christel Persson, Rytis Vilkonis, and Eija Yli-Panula in their research, learning through projects and experiences interacting or observing directly with environments experiencing problems can increase interest and understanding in preserving the environment (Palmberg et al., 2015). This is in line with research conducted by Nur, Syaipul, and Dyah, which states that recycling as a project in learning that applies an ESD approach can be one of the efforts to increase awareness of

environmental concerns such as preserving, protecting, and managing the environment (Khoiri et al., 2023).

CONCLUSION

Based on the research that has been conducted, it can be concluded that the Problem-Based Learning model with an Education for Sustainable Development approach has an effect on improving students' environmental awareness. This is evidenced by the difference in learning outcomes in environmental awareness, both in terms of environmental knowledge and indicators of conservation, preservation, and skills, between the experimental class that used the PBL model and the ESD approach and the control class that used the conventional lecture method. The differences produced have a very large effect, showing that learning using the PBL model and ESD approach is more appropriate than conventional models and lecture methods for improving environmental awareness skills. The PBL model with the ESD approach is more effective in science learning for seventh graders at SMPN 3 Ponorogo in improving environmental awareness skills than the conventional model and lecture method. For future researchers, it is recommended that learning innovations be developed with various other innovations to improve environmental awareness skills and create a sustainable environment.

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