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The Effect of Problem-Based Learning Assisted by Video on Students' Critical Thinking Skills and Environmental Literacy in Ecosystem Learning

Pengaruh Problem-Based Learning Berbantuan Video terhadap Keterampilan Berpikir Kritis dan Literasi Lingkungan Siswa dalam Pembelajaran Ekosistem

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Abstract. The low level of students' critical thinking skills and environmental literacy, as reflected in Indonesia's poor performance in PISA, along with the still-dominant use of conventional, teacher-centered learning methods, served as the background of this research. Which limit students' active participation and higher-order thinking development in ecosystem learning. This study aims to examine the effect of the Problem-Based Learning (PBL) model assisted by video media on students' critical thinking skills and environmental literacy in ecosystem learning. This study employed a quasi-experimental research design with a non-equivalent control group design. The research was conducted at SMAS Angkasa 1 Lanud Soewondo Medan, involving Grade X students in the even semester of the 2025/2026 academic year. Data were collected through pretest and post-test instruments measuring critical thinking skills and environmental literacy, which encompassed three components: knowledge, attitude, and behavior. The data analysis was performed using descriptive statistics and an independent sample t-test. The results indicate that students in the experimental class who were taught using the video-assisted PBL model demonstrated significantly higher critical thinking skills and environmental literacy scores compared to students in the control class who received conventional instruction. These findings contribute to the development of science, particularly by providing empirical evidence on the effectiveness of video-assisted PBL in enhancing critical thinking skills and environmental literacy, and by offering a reference for future research and innovation in biology education.

Keywords: *critical_thinking_skills; environmental_literacy; problem-based_learning; video_media; ecosystem_learning*

Abstrak. *Rendahnya kemampuan berpikir kritis dan literasi lingkungan siswa yang tercermin dari rendahnya hasil PISA Indonesia, serta masih dominannya penggunaan metode pembelajaran konvensional yang berpusat pada guru, menjadi latar belakang penelitian ini. Kondisi tersebut menyebabkan peserta didik kurang terlibat secara aktif dalam proses pembelajaran dan belum optimal dalam mengembangkan keterampilan berpikir tingkat tinggi, khususnya pada materi ekosistem. Penelitian ini bertujuan untuk mengkaji pengaruh model Problem-Based Learning (PBL) berbantuan media video terhadap kemampuan berpikir kritis dan literasi lingkungan siswa pada materi ekosistem. Penelitian ini menggunakan desain penelitian quasi eksperimen dengan rancangan non-equivalent control group design. Penelitian dilaksanakan di SMAS Angkasa 1 Lanud Soewondo Medan dengan melibatkan siswa kelas X pada semester genap tahun ajaran 2025/2026. Data dikumpulkan melalui instrumen pretest dan posttest yang mengukur kemampuan berpikir kritis dan literasi lingkungan yang mencakup tiga komponen, yaitu pengetahuan, sikap, dan perilaku. Analisis data dilakukan menggunakan statistik deskriptif dan uji independent sample t-test. Hasil penelitian menunjukkan bahwa siswa pada*

kelas eksperimen yang diajar menggunakan model PBL berbantuan video memiliki kemampuan berpikir kritis dan skor literasi lingkungan yang secara signifikan lebih tinggi dibandingkan siswa pada kelas kontrol yang memperoleh pembelajaran konvensional. Temuan ini memberikan kontribusi bagi perkembangan ilmu pengetahuan, khususnya dalam menyediakan bukti empiris mengenai efektivitas model PBL berbantuan video dalam meningkatkan kemampuan berpikir kritis dan literasi lingkungan siswa, serta menjadi rujukan bagi penelitian dan inovasi pembelajaran biologi selanjutnya.

***Kata Kunci**: kemampuan_berpikir_kritis; literasi_lingkungan; problem-based_learning; media_video; pembelajaran_ekosistem*

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1. Introduction

Education is a fundamental effort to create a learning environment and process for students to actively develop their potential. Biology, as a natural science discipline, requires engaging, meaningful, and contextual learning processes that encourage students to observe, experiment, and reason to explain natural phenomena (1).

The results of the Programme for International Student Assessment (PISA) show that Indonesian students' science literacy skills remain relatively low. In 2022, Indonesia ranked 69th out of 80 countries with an average science score of 383, still far below the international average (2). This condition highlights the need for innovative learning approaches that can develop higher-order thinking skills and scientific literacy.

Problem-Based Learning (PBL) is a learner-centered approach where the learning process begins with real-life contextual problems. Through investigation, collaboration, and reflection, learners are guided to build conceptual understanding and develop higher-order thinking skills (3). According to Arends (4), PBL consists of five stages: orienting students to the problem, organizing learning, guiding independent and group investigations, developing and presenting results, and analyzing and evaluating the problem-solving process.

Critical thinking skills are an essential component of 21st-century learning. Hamdani et al. (5) emphasize that critical thinking is part of the Higher Order Thinking Skills (HOTS) that students must possess. In biology learning, critical thinking is necessary for students to analyze phenomena, conduct investigations, and find solutions to environmental problems.

Environmental literacy is an individual's awareness of the need to maintain ecosystem balance, encompassing not only ecological knowledge but also responsive attitudes and concrete actions toward environmental conservation (6). Indonesian students' environmental literacy remains low, consistent with poor PISA science literacy scores.

Observations at SMAS Angkasa 1 Lanud Soewondo Medan showed that biology learning remained dominated by conventional lecture-based methods with limited use of learning media. Students demonstrated low critical thinking skills and environmental literacy, as they had minimal opportunities to analyze contextual problems or engage with real environmental phenomena.

To address these limitations, video media was incorporated to support the PBL model. Educational videos can present ecosystem phenomena visually and concretely, providing learning experiences closer to reality (7). The combination of PBL and video media is expected to improve both critical thinking skills and environmental literacy simultaneously.

The novelty of this research lies in its integrated examination of critical thinking skills and environmental literacy as two interrelated learning outcomes within a video-assisted PBL implementation, a perspective not commonly explored in previous studies. The research objective was to determine the effect of the video-

assisted PBL model on students' critical thinking skills and environmental literacy in ecosystem learning at SMAS Angkasa 1 Medan.

2. Methods

Research Location and Time

This study employed a quasi-experimental research design with a non-equivalent control group design (8). The research was conducted at SMAS Angkasa 1 Lanud Soewondo Medan, Jalan Polonia Ujung No. 99, Medan City, North Sumatra, during the even semester of the 2025/2026 academic year (February–May 2026).

Population and Sample

The population comprised all Grade X students of SMAS Angkasa 1 Medan in the even semester of 2025/2026. The sample was determined using total sampling. Class X-A (n=22) served as the experimental class receiving the video-assisted PBL model, while Class X-B (n=22) served as the control class receiving conventional direct instruction.

Table 1. Research Non-Equivalent Control Group Design

Class	Pre-test	Treatment	Post-test
Control	T1L1	–	T2L2
Experiment	T1L1	X	T2L2

Note: T1 = Critical thinking pretest; T2 = Critical thinking posttest; L1 = Environmental literacy pretest; L2 = Environmental literacy posttest; X = PBL treatment assisted by video; – = Conventional direct instruction

Research Instruments

Three types of instruments were used: (1) a critical thinking essay test (10 items) based on Ennis (9) indicators covering five aspects (providing simple explanations, building basic skills, making inferences, providing further explanations, and developing strategies and tactics); (2) an environmental literacy knowledge test (10 multiple-choice items) covering ecological knowledge, issue identification, issue analysis, and issue investigation; and (3) environmental literacy attitude and behavior questionnaires (10 items each) using a Likert scale (1–5). All instruments underwent validity testing (Pearson Product Moment), reliability testing (Cronbach's Alpha), difficulty level analysis, and discrimination index analysis prior to implementation.

Data Analysis

Data analysis was conducted in three stages. First, descriptive statistical analysis was performed to calculate mean scores and standard deviations for each variable. Critical thinking scores were categorized using Aiyub et al.(10) criteria (Very High, High, Moderate, Low, Very Low), while environmental literacy scores were categorized based on NELA (11) guidelines (High, Medium, Low). Second, prerequisite tests including the Shapiro-Wilk normality test and Levene's homogeneity test were conducted. Third, hypothesis testing was performed using the Independent Samples t-test ($\alpha = 0.05$) to determine significant differences between the experimental and control groups. Effect sizes were calculated using Cohen's d to determine the practical significance of the results.

3. Result and Discussion

Critical Thinking Skills

The descriptive statistics for students' critical thinking skills in both classes are presented in Table 4.1. Scores were assessed on a 0–4 scale per item (maximum raw score = 40), then converted to a final score (NA) on a 100-point scale.

Table 2. Critical Thinking Scores per Indicator

Critical Thinking Indicator	Control (Mean ± SD)	Experimental (Mean ± SD)
Provide a simple explanation	3.07 ± 1.00	3.51 ± 0.72
Build basic skills	2.05 ± 0.75	3.47 ± 0.91
Inference	2.25 ± 1.01	3.18 ± 1.25
Provide further explanation	2.40 ± 1.90	3.40 ± 1.46
Develop strategies and tactics	2.45 ± 2.04	3.09 ± 1.85
Total	25.72 ± 6.83	33.95 ± 4.81

Table 3. Distribution of Critical Thinking Categories

Category	Ctrl Pre F(%)	Ctrl Post F(%)	Exp Pre F(%)	Exp Post F(%)
Very High	2 (9.09)	2 (9.09)	1 (4.55)	13 (59.09)
High	2 (9.09)	5 (22.73)	3 (13.64)	6 (27.27)
Moderate	4 (18.18)	6 (27.27)	2 (9.09)	3 (13.64)
Low	8 (36.36)	5 (22.73)	8 (36.36)	0 (0)
Very Low	6 (27.27)	4 (18.18)	8 (36.36)	0 (0)

Based on Tables 2 and 3, the experimental class consistently achieved higher mean scores across all five critical thinking indicators. The most striking difference appeared in the building basic skills indicator (control: 2.05; experimental: 3.47), while the developing strategies and tactics indicator was lowest in the experimental class (3.09). After treatment, 13 students (59.09%) in the experimental class reached the very high category and no students remained in the low or very low categories, contrasting with the control class where 4 students (18.18%) remained in the very low category. The hypothesis test confirmed a significant difference (t-count = 4.617 > t-table = 2.018, $p < 0.001$), and Cohen's d = 1.39 indicated a large practical effect, the highest t-count among all four research variables.

These results align with the core mechanism of PBL by requiring students to identify ecological problems through video, evaluate information sources, analyze data, and formulate solutions in LKPD worksheets, PBL directly stimulates all five critical thinking indicators proposed by Ennis [9]. The building basic skills indicator showed the widest gap because conventional lecture-based learning in the control class did not provide students with opportunities to independently evaluate and verify information, as all content was delivered directly by the teacher. The developing strategies and tactics indicator was lowest even in the experimental class, consistent with Darma et al. (12), who noted that this higher-order competency requires more than three learning sessions to develop fully. The smaller standard deviation in the experimental class (4.81 vs. 6.83) confirms that PBL created more equitable learning outcomes across students of varying initial abilities. This finding is consistent with Lutfiah et al. (13) and Fahmi et al. (14), who found that video-assisted PBL significantly improved students' critical thinking skills in ecosystem learning by presenting real ecological problems that demanded active cognitive processing rather than passive reception of information.

Environmental Literacy in the Knowledge Aspect

The knowledge aspect of environmental literacy was measured using a 10-item multiple-choice test. Each correct answer was scored 1 point (maximum = 10), then converted to a 100-point scale. Descriptive statistics and category distributions are presented in Tables 4 and 5.

Table 4. Environmental Literacy Knowledge Scores per Indicator

EL Knowledge Indicator	Control (Mean ± SD)	Experimental (Mean ± SD)
Ecological knowledge	0.71 ± 0.45	0.95 ± 0.20
Identify environmental issues	0.56 ± 0.50	0.79 ± 0.79
Environmental issue analysis	0.36 ± 0.48	0.62 ± 0.62
Environmental issues investigation	0.70 ± 0.46	0.77 ± 0.49
Total	5.72 ± 1.57	7.68 ± 0.41

Table 5. Distribution of Environmental Literacy Knowledge Categories Control and Experimental Classes

Category	Ctrl Pre F(%)	Ctrl Post F(%)	Exp Pre F(%)	Exp Post F(%)
High	4 (18.18)	9 (40.91)	1 (4.55)	16 (72.73)
Moderate	12 (54.55)	11 (50.00)	15 (68.18)	6 (27.27)
Low	6 (27.27)	2 (9.09)	6 (27.27)	0 (0)

Based on Tables 4 and 5, the experimental class achieved higher mean scores across all four knowledge indicators. The ecological knowledge indicator yielded the highest mean in both classes and also showed the largest cross-class gap (experimental: 0.95 vs. control: 0.71). The environmental issue analysis indicator was the lowest in both classes (experimental: 0.62; control: 0.36), indicating that analytical competencies are the most difficult to develop within a short intervention. After treatment, 16 students (72.73%) in the experimental class reached the high category and no students remained in the low category, while the control class still had 2 students (9.09%) in the low category with 50% remaining at the moderate level. The hypothesis test confirmed a significant difference (t-count = 4.307 > t-table = 2.018, $p < 0.001$), and Cohen's d = 1.70 was the largest effect size across all four variables.

The largest effect size for the knowledge aspect reflects the primary mechanism of video-assisted PBL: active knowledge construction through visual contextualization and guided inquiry. YouTube videos presenting real ecosystem phenomena such as deforestation, food chain disruptions, biogeochemical cycles allowed students to connect abstract ecological concepts with concrete observable conditions, making conceptual understanding more effective than textbook-based explanation alone. Bambang et al. (15) confirmed that visual media provides clearer representations of ecosystem phenomena difficult to observe directly, particularly in urban schools with limited opportunities for field observation. The environmental issue analysis indicator remained lowest because the analytical process requires multi-step causal reasoning that is inherently more cognitively demanding and benefits from sustained practice, consistent with Bidahyani et al. (16). The much smaller standard deviation in the experimental class (0.41 vs. 1.57) reflects more consistent mastery, suggesting that PBL's

collaborative investigation stages distributed knowledge gains more equitably across students. This is consistent with Yusriana et al. (17) and Harahap et al. (18), who found that PBL significantly improved the knowledge aspect of environmental literacy by making ecological concepts more contextual and personally meaningful.

Environmental Literacy in the Attitude Aspect

The attitude aspect of environmental literacy was measured using a 10-item Likert scale questionnaire (1–5 scale) covering three indicators: views on the environment, environmental sensitivity, and feelings toward the environment (maximum score = 50, converted to 100-point scale).

Table 6. Environmental Literacy Attitude Scores per Indicator

EL Attitude Indicator	Control (Mean ± SD)	Experimental (Mean ± SD)
Views on the environment	4.62 ± 0.71	4.83 ± 0.41
Environmental sensitivity	3.77 ± 0.83	4.57 ± 0.80
Feelings toward the environment	4.44 ± 0.75	4.63 ± 0.79
Total	43.81 ± 2.88	46.40 ± 2.77

Table 7. Distribution of Environmental Literacy Attitude Categories Control and Experimental Classes

Category	Ctrl Pre F(%)	Ctrl Post F(%)	Exp Pre F(%)	Exp Post F(%)
High	21 (95.45)	22 (100)	20 (90.91)	22 (100)
Moderate	1 (4.55)	0 (0)	2 (9.09)	0 (0)
Low	0 (0)	0 (0)	0 (0)	0 (0)

Based on Tables 6 and 7, the experimental class achieved higher mean scores across all three attitude indicators. The most striking difference appeared in the environmental sensitivity indicator (experimental: 4.57 vs. control: 3.77), while views on the environment was the highest in both classes. In the post-test, all 22 students in both classes reached the high category (identical categorical distributions). Despite this, the hypothesis test confirmed a statistically significant difference in mean scores (t-count = 3.035 > t-table = 2.018, p = 0.004), and Cohen's d = 0.91 indicated a large practical effect. This pattern reflects a ceiling effect: both classes already showed predominantly high attitude levels in the pretest (control: 95.45%; experimental: 90.91%), limiting categorical differentiation.

The ceiling effect and the smaller effect size relative to the other three variables are partly attributable to social desirability bias, respondents tend to provide more positive responses to environmental attitude questionnaires because environmental responsibility is perceived as socially desirable(19). Nevertheless, the statistically significant mean difference confirms that the quality and intensity of environmental attitudes in the experimental class were meaningfully higher. The environmental sensitivity indicator showed the largest gap because video media provided stronger visual and emotional stimuli related to real ecosystem degradation footage of deforestation, coral reef damage, and polluted waterways producing greater affective responses than text-based instruction. This is consistent with Nabila et al. (20) and Laelasari and Rahmawati (21), who found that PBL positively developed students' environmental sensitivity and awareness attitudes by engaging them with authentic ecological problems. The

significant mean difference despite categorical equivalence indicates that PBL not only maintained positive environmental attitudes but elevated their quality to a higher level.

Environmental Literacy in the Behavior Aspect

The behavior aspect of environmental literacy was measured using a 10-item Likert scale questionnaire (1–5 scale) focused on the indicator of responsibility for the environment, encompassing cleanliness habits, resource conservation, participation in environmental activities, and green decision-making (maximum score = 50, converted to 100-point scale).

Table 8. Environmental Literacy Behavior Scores per Indicator

EL Behavior Indicator	Control (Mean ± SD)	Experimental (Mean ± SD)
Responsibility for the environment	4.33 ± 0.29	4.64 ± 0.24
Total	43.36 ± 2.98	46.40 ± 2.46

Table 9. Distribution of Environmental Literacy Behavior Categories Control and Experimental Classes

Category	Ctrl Pre F (%)	Ctrl Post F (%)	Exp Pre F (%)	Exp Post F (%)
High	18 (81.82)	22 (100)	17 (77.27)	22 (100)
Moderate	4 (18.18)	0 (0)	5 (22.73)	0 (0)
Low	0 (0)	0 (0)	0 (0)	0 (0)

Based on Tables 8 and 9, the experimental class obtained a higher mean score on the responsibility for the environment indicator (4.64 vs. 4.33), with a smaller standard deviation (0.24 vs. 0.29) indicating more consistent behavioral commitment. In the pretest, 4–5 students in each class (18–22%) were still in the moderate category. After treatment, all students in both classes reached the high category. The hypothesis test confirmed a highly significant difference (t-count = 3.692 > t-table = 2.018, $p < 0.001$), and Cohen's d = 1.11 indicated a large practical effect, higher than the attitude aspect (0.91) despite similar distributional patterns in the post-test.

The larger Cohen's d for the behavior aspect compared to the attitude aspect (1.11 vs. 0.91) is a noteworthy finding that reflects the action-oriented structure of PBL. While the attitude aspect is primarily developed through affective exposure and awareness-building processes susceptible to social desirability bias, behavioral commitment is more directly stimulated through PBL's problem-solving and solution-development stages. When students in the experimental class developed concrete solutions to ecological problems in their LKPD worksheets (such as addressing eutrophication from excessive fertilizer use, or restoring food chain balance after a species decline), they were practicing the form of environmental agency that pro-environmental behavior represents. This experience of environmental agency translates more directly into behavioral intention than passive attitude formation through lecture. This finding is consistent with Nabila et al. (20), who found that PBL improved the behavioral aspect of environmental literacy more effectively than conventional learning by engaging students in authentic problem-solving activities. Apriani et al. (22) further

emphasized that environmentally literate individuals must translate knowledge and attitudes into concrete actions, and PBL's structure directly scaffolds this translation. The mean score difference of 3.04 points (46.40 vs. 43.36), representing the largest absolute difference among the three EL aspects, further confirms the strong influence of video-assisted PBL on students' pro-environmental behavioural commitment.

4. Conclusion

The implementation of the video-assisted Problem-Based Learning (PBL) model at SMAS Angkasa 1 Medan significantly improved students' critical thinking skills and environmental literacy in ecosystem learning. Statistically significant differences were found for all four measured variables which are critical thinking skills (d = 1.39), environmental literacy knowledge (d = 1.70), environmental literacy attitudes (d = 0.91), and environmental literacy behaviors (d = 1.11), and all showing large effect sizes. This research contributes to the field of biology education by providing empirical evidence that the video-assisted Problem-Based Learning (PBL) model is effective in improving students' critical thinking skills and environmental literacy. The findings enrich the existing body of knowledge regarding innovative learning approaches that integrate problem-solving activities with multimedia support to foster 21st-century competencies. Furthermore, this study expands the understanding of environmental literacy development by demonstrating that video-assisted PBL can significantly enhance students' environmental knowledge, attitudes, and behaviors simultaneously. The large effect sizes obtained across all measured variables indicate that this instructional model has strong potential as an evidence-based strategy for improving biology learning outcomes, particularly in ecosystem education. Future research is recommended to explore this model in other biology topics, other educational levels, or with additional outcome variables such as learning motivation and problem-solving skills.

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