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Building ecological awareness in coastal elementary schools: The impact of problem-based learning and learning motivation

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Abstract

This study aims to examine the influence of the Problem-Based Learning (PBL) model and learning motivation on students' ecological awareness in social studies education at elementary schools in the coastal area of Cluster II Gending, Probolinggo Regency. A quantitative approach was employed, using a survey of 80 students from five randomly selected elementary schools. Data were collected through validated and reliable questionnaires, supported by observations and interviews. Data analysis used multiple linear regression. Statistical tests showed that the PBL model and learning motivation simultaneously had a significant effect on students' ecological awareness, with a significance value (Sig) of 0.000 < 0.05 and an R^2 value of 0.623, indicating that both variables contributed 62.3% to ecological awareness. Partially, the PBL model had a significant effect (Sig = 0.003), as did learning motivation (Sig = 0.001). These findings suggest that the PBL model provides authentic and contextual learning experiences, while learning motivation enhances student engagement and internalization of ecological values. Based on the interview results, ecological awareness is formed not only by conceptual understanding but also by affective factors. The implication is that combining problem-based learning strategies with strengthened learning motivation can serve as a foundation for developing sustainable ecological character through Social Studies education at the elementary level.

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1. Introduction

The current environmental crisis has become a pressing global issue that demands immediate attention, including through educational pathways. Problems such as pollution, ecosystem degradation, and climate change require the cultivation of ecological awareness from an early age. This approach is in line with the Sustainable Development Goals (SDGs) agenda, particularly goal 4 on "Quality Education" which emphasizes the importance of education to support sustainability, goal 12 on "Climate Action", and goals 14 and 15 on "Conservation of Marine and Terrestrial Ecosystems" (Guo et al., 2025). Previous research (Ydesen & Elfert, 2023) shows that education can contribute directly to achieving

SDG targets by strengthening environmental literacy, critical thinking skills, and pro-environmental behavior.

Basic education in Indonesia requires a stimulus to provide sustainability-oriented learning, both through the integration of environmental awareness and contextual learning experiences. In this regard, Social Studies (IPS) education as part of the elementary school curriculum holds significant potential in shaping students' understanding, attitudes, and environmentally conscious behaviors (Ibrahimi, 2025).

However, preliminary observations in elementary schools within Cluster II Gending, Gending District, Probolinggo Regency, reveal that Social Studies learning remains predominantly passive and teacher-centered. This conventional approach has not effectively fostered students' active engagement with social and environmental issues in their surroundings (Siregar et al., 2025). As a result, students exhibit low learning motivation and weak ecological awareness, as reflected in their limited participation in school-based environmental activities such as cleanliness programs, recycling, or greening initiatives.

This issue is particularly critical given that Gending District, located in Probolinggo Regency, is a coastal area vulnerable to environmental changes such as coastal erosion, marine pollution, and sanitation crises. Therefore, schools in this region must go beyond cognitive instruction and actively cultivate ecological attitudes and behaviors through learning processes. One promising instructional model that addresses these challenges is Problem-Based Learning (PBL). The selection of the problem-based learning model in this study is based on constructivist theory, which places students as active subjects in constructing knowledge through experience and interaction with the learning environment (Johnson et al., 2023). Model Problem-Based Learning emphasizes students' active involvement in solving real-world problems relevant to their lives, including local environmental issues (Arifin & Hasanah, 2024). It is believed to stimulate curiosity, critical thinking, and authentic concern for the environment.

PBL is considered effective in fostering ecological awareness because it encourages students to actively identify, analyze, and seek solutions to real environmental problems (Ardoin & Bowers, 2020). This process engages not only cognitive aspects but also students' affective and psychomotor domains, leading to comprehensive changes in ecological attitudes and behaviors. From a theoretical standpoint, the development of students' ecological awareness through PBL can be explained using the ecological behavior theory, which posits that pro-environmental actions are influenced by a combination of environmental knowledge, values, personal norms, and behavioral intentions (Saracho, 2023).

In elementary Social Studies education, implementing PBL allows students to understand environmental issues within their own socio-cultural context, such as waste management, pollution, or nature conservation around the school.

According to Varadarajan and Ladage (2024), PBL fosters emotional engagement with environmental issues, nurtures empathy, and motivates students to take proactive actions in environmental stewardship. This shows that PBL not only enhances conceptual understanding but is also effective in instilling sustainable ecological values. From the perspective of learning theory, these processes can be explained through Kolb's Experiential Learning Theory, which proposes that learning occurs through a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation (Morris, 2020). PBL operationalizes this cycle by allowing students to experience authentic environmental problems, reflect on their implications, conceptualize environmental principles, and design or test solutions within their immediate environment.

Previous research supports the effectiveness of PBL in increasing environmental awareness. Research to Kamil et al. (2020) found that PBL improved ecological literacy among elementary school students through environmental projects at Adiwiyata schools. Similarly, (Rianti et al., 2024) reported that PBL in thematic learning improved students' ecological intelligence. On the other hand, learning motivation is also a crucial factor in the success of the learning process. Highly motivated students tend to be more enthusiastic, persistent, and responsive to the material presented. Unfortunately, most studies have examined either PBL or learning motivation in isolation, without exploring the potential interaction between the two in shaping ecological awareness (Ikhsan, 2020).

In addition, ecological awareness theoretically refers to the Value-Belief-Norm (VBN) theory, which explains that pro-environmental behavior emerges through the activation of environmental values, ecological beliefs, and personal moral norms (Fornara et al., 2020). The Value-Belief-Norm (VBN) theory in the application of the PBL learning model can influence students' sense of responsibility towards environmental issues and ultimately provide a stimulus for ecological action. This implies that PBL can not only influence the cognitive dimension but can also form normative commitments and behavioral intentions that are consistent with building ecological awareness in elementary school students.

This study addresses that gap by not only implementing a PBL-based intervention but also examining the extent to which students' learning motivation contributes to the development of their ecological awareness. Conducted in elementary schools within Cluster II Gending, this research holds strong local relevance and has the potential to serve as a valuable reference for developing contextual learning models in coastal areas. The study aims to investigate the influence of the Problem-Based Learning model and learning motivation on students' ecological awareness in Social Studies education. Additionally, it

explores whether learning motivation acts as a moderating variable in the relationship between PBL implementation and ecological awareness.

The novelty of this research lies in its integration of problem-based learning and motivational dimensions in shaping ecological awareness, particularly in elementary Social Studies education. While most previous studies have focused on these aspects separately, this study examines both simultaneously and in depth within the context of coastal primary education. Thus, the findings are expected to contribute both theoretically and practically to the development of more meaningful, contextual, and environmentally oriented Social Studies instruction.

2. Methods

This study uses a quantitative approach with a survey method to analyze the influence of the Problem-Based Learning model and student learning motivation on the ecological awareness of elementary school students. The study population consisted of 271 students in grades IV and V at five elementary schools in Cluster II Gending, Probolinggo Regency. The research sample was determined using a proportional sampling technique of 30% of the population, resulting in 80 students in each school. The selection of grades IV and V students was based on considerations of the concrete operational stage according to Jean Piaget's cognitive development theory, so that cognitively, students were assessed as being able to understand social and environmental phenomena in the context of everyday life (Devi, 2019).

Data were collected through classroom observations, questionnaires, and semi-structured interviews as a form of triangulation to increase the depth and accuracy of the findings. The questionnaires were constructed using a five-point Likert scale to measure three main variables, aimed at capturing students' perceptions and attitudes toward each variable (Haris et al., 2023) The questionnaire instrument was designed on three main variables, namely; 1) implementation of the Problem-Based Learning (PBL) model (X3), emphasizing real problem solving to increase students' active understanding (Jihan Nabila et al., 2025). Questionnaire indicators based on the quality of the problems presented, the level of student involvement in solving problems, the use of learning resources, and students' ability tos formulate hypotheses or solutions, students' learning motivation, and students' ecological awareness; 2) learning motivation (X2), refers to internal and external drives that influence student involvement in environmentally oriented social studies learning (Taylor, R., & Evans, 2020). Questionnaire indicators based on interest in the subject, commitment in completing assignments, persistence in understanding environmental concepts, and active participation in discussions; and 3) ecological awareness (Y), students' attitudes and behavior in understanding, caring about,

and acting in an environmentally friendly manner (Hendrawan et al., 2020). The questionnaire indicators are based on an understanding of environmental issues, concern for surrounding conditions, behavior that supports environmental preservation, and involvement in ecology-based activities. Observations focused on the dynamics of student interactions during social studies learning using the PBL model, while interviews explored students' reasons, intrinsic motivations, and personal connections to environmental issues.

Prior to data collection, the research instrument was tested for validity and reliability to ensure measurement accuracy and consistency. Validity testing was conducted through item-total correlation at a 5% significance level, and all items were declared valid because they were able to represent the constructs being measured. Reliability testing using the Cronbach's Alpha coefficient showed a value of 0.974 for the PBL variable, 0.968 for ecological awareness, and 0.847 for learning motivation. All of these values exceeded the minimum limit of 0.70; the instrument was declared highly reliable and suitable for use in research.

Quantitative data analysis was conducted through descriptive statistics and inferential statistics through multiple linear regression tests to determine the partial and simultaneous effects of PBL and learning motivation on ecological awareness. Meanwhile, qualitative data analysis from the interview data was used to identify patterns and themes related to students' ecological motivation and attitudes.

3. Results

Before testing the hypothesis using the ANOVA test, the research data were first tested through analysis prerequisite tests, which included the normality test and the homogeneity of variance test. The results of the normality test showed a significance value (Sig.) of 0.200, while the results of the homogeneity of variance test showed a significance value of 0.318, both of which were greater than 0.05. This indicates that the data were normally distributed and had homogeneous variance. Therefore, the research data were declared to meet the assumptions of parametric statistical analysis, so that hypothesis testing could be continued using the ANOVA test.

3.1 Simultaneous effect of PBL and motivation on ecological awareness

The results of the ANOVA test on hypothesis 1 showed an F value of 227.006 with a significance level (Sig.) of 0.000, which is far below the threshold of 0.05.

Table 1.
Anova Summary

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4823.858	3	1607.953	227.006	0.000
Residual	538.330	76	7.083		
Total	5362.188	79			

Source: Data Test Results Using The SPSS Application

Based on the ANOVA test in Table 1 above, these findings indicate that a comprehensive approach combining problem-based learning and increased student motivation is effective in fostering ecological awareness in social studies learning in elementary schools.

3.2 Partial effect of PBL on ecological awareness

The regression analysis revealed a t-value of 3.613 and a significance level (Sig.) of 0.001, which is below the 0.05 threshold. This confirms that PBL has a statistically significant positive effect on ecological awareness.

Table 2.
Partial Regression Results for PBL Variable

Variable	B	Std. Error	Beta	t	Sig.
(Constant)	3.398	2.481	—	1.370	0.175
PBL	0.332	0.092	0.319	3.613	0.001

Source: Data Test Results Using The SPSS Application

Referring to the results in Table 2 above, these findings suggest that contextual, problem-based learning plays a vital role in cultivating ecological awareness among elementary students, especially when addressing local environmental issues. Educators are encouraged to integrate PBL into Social Studies instruction to foster critical thinking and environmental responsibility.

3.3 Partial Effect of Learning Motivation on Ecological Awareness

The regression analysis yielded a t-value of 2.787 and a significance level (Sig.) of 0.007, confirming a statistically significant positive effect of learning motivation on ecological awareness.

Table 3.
Partial Regression Results for Learning Motivation

Model	Unstandardized Coefficients	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	3.398	2.481		1.370	0.175
Motivation	0.311	0.111	0.352	2.787	0.007

Source: Data Test Results Using The SPSS Application

As shown in Table 3 above, these results highlight the importance of cultivating student motivation to increase ecological awareness. Motivated students are more likely to engage deeply with environmental content, reflect on its relevance, and adopt environmentally responsible behaviors. Therefore,

teachers must create a learning environment that stimulates intrinsic motivation through active methods, engaging media, and meaningful assessments.

Based on the results of the descriptive analysis, the average of each research variable shows a relatively close value. The variable of the application of the Problem-Based Learning (PBL) model has an average value of 61.7, followed by the ecological literacy variable of 61.9, the learning motivation of 61.4, and the environmental awareness of 61.2. In general, the average value is in the moderate category, which indicates that the level of application of the learning model, ecological literacy, learning motivation, and environmental awareness of students is quite good, but still needs strengthening to reach a higher category.

This finding is in line with research Rachman et al., (2020) suggesting implementing a problem-based learning model can increase student engagement in learning while strengthening their understanding of environmental issues. The problem-based learning model encourages students to actively examine real-world problems, engage in discussions, and collaboratively develop solutions, thereby enhancing ecological literacy and environmental awareness. Furthermore, strong learning motivation plays a crucial role in encouraging students to engage more deeply in the learning process and gain a more comprehensive understanding of environmental issues (Qasem et al., 2025).

4. Discussion

4.1. The Simultaneous Influence of PBL and Learning Motivation on Students' Ecological Awareness in Social Studies

The results of the study show that problem-based learning models and learning motivation play a significant role in increasing students' ecological awareness in Social Sciences (IPS) learning. This finding not only meets the research objectives but also broadens the understanding of how the interaction between pedagogical approaches and students' internal factors can shape positive ecological attitudes. The results of the multiple regression analysis obtained a Sig. value ($0.000 < 0.05$), indicating that contextual and participatory learning strategies will be more effectively implemented when supported by high student motivation (Gök & Boncukçu, 2023).

The results were obtained through a quantitative survey approach, using Likert-scale questionnaires to measure learning motivation and ecological awareness, as well as structured observations of PBL implementation in classrooms. Data analysis using multiple linear regression confirmed a significant and positive relationship between PBL and learning motivation toward ecological awareness. Additionally, qualitative notes from classroom reflections supported the idea that students were more emotionally and cognitively engaged when dealing with authentic local environmental problems. This supports findings from

(Nicholus et al., 2025), who emphasized that PBL fosters deep engagement by exposing learners to real-world complexities. The interpretation shows that ecological awareness formation cannot rely solely on knowledge transfer, but must be facilitated by strategies that promote ownership and responsibility for the environment (Yunansah & Herlambang, 2017; Hasni et al., 2025).

PBL provides opportunities for students to experience meaningful, contextual, and challenging learning. When implemented effectively and combined with intrinsic motivation, students not only acquire ecological concepts but also demonstrate real-life applications. This is consistent with (Muerza et al., 2024), who found that PBL enhanced students' motivation, communication, and understanding. Similarly, (Li & Xue, 2023) through meta-analysis confirmed that problem-driven learning methods significantly increase student motivation and sustained engagement. In this research, students with higher motivation levels were more active in inquiry, more reflective in learning processes, and more committed to real actions, consistent with , who demonstrated that motivation predicts learning effectiveness through engagement.

By integrating these findings, this study enriches the framework of environmental education in social studies by highlighting the psychological dimensions of students as framed in Self-Determination Theory (SDT). These dimensions include autonomy, competence, and relatedness, which, when satisfied, can foster consistent ecological behavior (Shih, 2024). For example, in coastal-area elementary schools in Gending, students were allowed to choose local issues such as beach waste management and collaboratively designed recycling projects. This practice strengthened their sense of ownership and ecological responsibility, similar to (Putu et al., 2025), who found that project-based learning enhanced empathy and ecological awareness in social studies.

Thus, PBL is not only confirmed as effective but also expanded as a means of fostering sustainable ecological character, including consistent waste sorting habits, empathy toward nature, and long-term commitment to environmental stewardship. Previous studies, such as Ilma & Wulandari (2023) and (Seran et al., 2023), also demonstrated that PBL improved ecological literacy and environmental care attitudes among elementary students. Therefore, a learning approach that combines contextual strategies and motivational reinforcement becomes a critical foundation for developing transformative ecopedagogy in primary education (Zhang & Ma, 2023). Transformative ecopedagogy views learning as a tool to reshape students' ecological values through critical reflection and contextual environmental action, enabling students not only to acquire knowledge but also to develop ecological identity and sustainable commitments (Husin et al., 2025).

4.2. The Influence of Problem-Based Learning (PBL) on Students' Ecological Awareness in Social Studies

This study demonstrates that PBL significantly influences the improvement of students' ecological awareness in social studies. The results were obtained through a quantitative survey with validated Likert-scale instruments. Regression analysis confirmed that PBL had a positive and significant effect on ecological awareness, with significance values below 0.05 and strong regression coefficients. The results of this study confirm the basic assumptions of constructivist theory, which positions students as active subjects in constructing knowledge through authentic experiences and contextual problem-solving (Almulla, 2023). Within this framework, PBL encourages the processes of assimilation and accommodation, as proposed by Jean Piaget, so that students do not simply receive information about the environment but construct ecological understanding through direct interaction with real-world problems (Kadarisman et al., 2023). These findings align with (Kholifah et al., 2024), who reported that Environmental-Oriented PBL significantly increased ecological awareness and problem-solving skills in environmental issues at the high school level. Similarly, (Ilma & Wulandari, 2023) found that PBL applied to environmental themes improved elementary students' ecological literacy.

Interpretation suggests that PBL allows students to directly engage with contextual environmental issues. Students not only receive information but are challenged to think critically, explore solutions, and take a stance. This is also consistent with (Seran et al., 2023), who noted that PBL students demonstrated improved environmental attitudes and teamwork in addressing local problems. PBL offers authentic experiences that demand cognitive and emotional involvement, extending students' ecological understanding of social-environmental relations (Gök & Boncukçu, 2023).

Theoretically, these results expand the understanding of PBL beyond academic achievement (Almulla, 2020). They show that PBL is also effective in shaping ecological character through cognitive and reflective processes. This strengthens the constructivist foundation of PBL within environmental education, particularly in social studies at the elementary level. Consequently, it can be explicitly concluded that PBL significantly contributes to the enhancement of students' ecological awareness.

4.3. The Influence of Learning Motivation on Students' Ecological Awareness in Social Studies

The results of the study indicate that students' learning motivation has a positive and significant influence on ecological awareness in social studies learning. Theoretically, this finding can be explained through the theory of learning motivation, which asserts that internal and external drives determine the intensity of an individual's involvement in the learning process (Luarn et al., 2023).

From the perspective of Self-Determination Theory, developed by Edward L. Deci and Richard M. Ryan, intrinsic motivation encourages individuals to engage voluntarily, with interest, and reflectively in an activity (Ryan & Deci, 2023). When students are highly motivated, they are not only focused on completing assignments but also on understanding the meaning and value of the material they are studying, including environmental issues. This process of internalizing values contributes to the development of ecological awareness (Noordwijk et al., 2023).

In addition, the research findings are also in line with the expectancy-value theory, which states that students will show greater involvement when they view learning as valuable and relevant to their lives (Beymer et al., 2022). In the context of environmentally based social studies learning, strong motivation makes students more active in exploring ecological issues, reflecting on the impact of human behavior on the environment, and demonstrating consistency in their environmental awareness. This is evidenced by the results of partial regression analysis showing a significant contribution of learning motivation to ecological awareness (sig. <0.05) with a strong coefficient. Thus, conceptually, it can be understood that learning motivation plays a psychological role that drives students' cognitive and affective engagement, which ultimately strengthens the formation of ecological awareness (Lei et al., 2024).

This finding is consistent with Rambe et al. (2024), who found a positive correlation between learning motivation and students' environmental concern in school contexts. It also aligns with Self-Determination Theory, which argues that autonomy, competence, and relatedness foster intrinsic motivation (Mendoza et al., 2023). When these needs are met, students are more likely to internalize ecological values (Adela & Permana, 2020). In this study, students who felt ownership of projects and competence in solving real problems showed stronger ecological commitments (Putu et al., 2025).

Theoretically, this strengthens the notion that ecological awareness is not merely a cognitive outcome but also shaped by affective dimensions such as motivation (Sumiaty et al., 2022). (Husin et al. (2025) also demonstrated that motivation mediates the effectiveness of problem- and project-based learning. Therefore, learning strategies that enhance intrinsic motivation—such as meaningful projects are effective in cultivating ecological awareness (Muerza et al., 2024). Explicitly, this research concludes that learning motivation significantly influences ecological awareness, confirming its role as an inseparable component of character education in environmental-oriented social studies.

This research has several limitations that need to be considered as material for reflection and development of further studies. First, the study was conducted within the context of a specific geographic area and educational institution, namely elementary schools in Cluster II Gending, Probolinggo Regency. The

ecological, social, and cultural contexts of these areas can influence the acceptance of problem-based learning pathways. Therefore, generalizing the findings to other areas with different social ecologies, such as urban or agrarian areas, requires caution. Second, this study focused on outcomes in the form of increased ecological awareness but did not measure more behavioral ecological changes or long-term concrete actions, such as consistent waste sorting, reduced plastic consumption, or participation in conservation activities. This is important because in ecological education, ideal learning outcomes do not stop at the cognitive and affective domains but should progress toward sustainable ecological actions as a manifestation of internalized values.

5. Conclusion

This study aimed to examine the influence of the Problem-Based Learning (PBL) model and students' learning motivation on ecological awareness in Social Studies education at elementary schools in Cluster II Gending, Probolinggo Regency. Based on the results of data analysis and discussion, it can be concluded that both PBL and learning motivation have a significant impact, both simultaneously and individually, on enhancing students' ecological awareness.

Simultaneously, the combination of a contextual and participatory PBL approach with high learning motivation proved to be an effective strategy for cultivating ecological awareness. PBL offers meaningful learning experiences by engaging students with real environmental problems in their surroundings, stimulating cognitive, affective, and behavioral involvement. Meanwhile, learning motivation strengthens this engagement, encouraging students to understand Social Studies content more deeply and apply it in their daily lives.

Individually, the PBL model significantly contributes to ecological awareness by presenting authentic, locally relevant problem-solving situations. This enables students to grasp the interconnection between humans and the environment within a social context. Likewise, learning motivation positively influences ecological awareness. Highly motivated students tend to be more active, reflective, and consistently demonstrate pro-environmental attitudes, reinforcing their understanding and concern for ecological issues.

In addition to these findings, this study contributes theoretically and practically to social studies (IPS) learning. Theoretically, this research enriches the study of environmental education in social studies by demonstrating that ecological awareness is shaped not only by environmental knowledge but also by learning design and motivation that foster student engagement. The integration of problem-based learning models and motivational aspects extends previous research by confirming the relevance of both in building ecological awareness at the elementary school level.

Practically, this study offers an instructional framework for teachers and curriculum developers by identifying the relationship between problem-based learning models and motivation as strategic pathways for fostering ecological awareness. The use of contextualized environmental issues and student-driven inquiry provides a model that can be adapted in social studies learning to strengthen critical thinking, responsibility, and pro-environmental attitudes.

Despite these contributions, this study is limited by its geographic scope, which only included elementary schools in Cluster II Gending, and by its focus, which emphasized awareness rather than sustainable ecological behavior. Given these limitations, future research could employ longitudinal or mixed-methods designs to explore how ecological awareness develops into sustainable ecological actions in various social and ecological contexts. Comparative studies across regions and interventions with reinforcement mechanisms also have the potential to increase the external validity and pedagogical relevance of findings. Such research efforts will deepen understanding of the contribution of Social Studies (IPS) learning to the formation of sustainable ecological citizenship over the long term.

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