Innovations in Pedagogy and Technology
https://journals.niepublish.com/ipt

ARTICLE

Enhancing Students' Critical Thinking and Ecoliteracy through Geo-Outdoor Contextual Problem-Based Learning

Suwarno * **, *Muh. Sholeh*** **, *Edi Kurniawan*** **, *Andi Irwan Benardi***

Department of Geography, Universitas Negeri Semarang, Semarang 50229, Indonesia

ABSTRACT

Geography is one of the most strategic subjects for fostering knowledge, values, and environmental behavior in senior high schools. One learning model that can be applied in geography instruction is the outdoor study or fieldwork approach, which can be further combined with problem-based learning (PBL). Problem-based learning is more effective when built on contextual issues, as the starting point of PBL lies in real-life problems relevant to students' experiences. This study aims to analyze the effectiveness of the contextual problem-based outdoor study model (Geo-Outdoor CPBL) in enhancing students' critical thinking skills and ecoliteracy in geography learning at the senior high school level. The research employed an experimental design with a quantitative approach. It was conducted with one study group, specifically an 11th-grade class at SMA Negeri 1 Getasan, Semarang Regency, Central Java Province, Indonesia, involving 36 students. Data were collected using tests and questionnaires. The data analysis techniques included quantitative descriptive analysis, paired sample *t*-test, and N-Gain Score analysis. The findings indicate that the Geo-Outdoor CPBL model is effective in improving both critical thinking and ecoliteracy skills. The pretest–posttest results show a significant increase in the average score (from 41.67 to 83.92), with the paired *t*-test result at $p < 0.05$. This model supports 21st-century learning competencies by fostering critical thinking, problem-solving, creativity, collaboration, and communication.

Keywords: Contextual Learning; Ecoliteracy; Geography Education; Geo-Outdoor CPBL; Outdoor Study; Problem-Based Learning

*CORRESPONDING AUTHOR:
Suwarno, Department of Geography, Universitas Negeri Semarang, Semarang 50229, Indonesia; Email: suwarnokencur@students.unnes.ac.id

ARTICLE INFO
Received: 9 October 2025 | Revised: 17 February 2026 | Accepted: 24 February 2026 | Published Online: 2 March 2026
DOI: https://doi.org/10.63385/ipt.v2i2.331

CITATION
Suwarno, Sholeh, M., Kurniawan, E., et al., 2026. Enhancing Students' Critical Thinking and Ecoliteracy through Geo-Outdoor Contextual Problem-Based Learning. Innovations in Pedagogy and Technology. 2(2): 59–75. DOI: https://doi.org/10.63385/ipt.v2i2.331

COPYRIGHT
Copyright © 2026 by the author(s). Published by Nature and Information Engineering Publishing Sdn. Bhd. This is an open access article under the Creative Commons Attribution 4.0 International (CC BY 4.0) License (https://creativecommons.org/licenses/by/4.0).

1. Introduction

1.1. Background of the Study

Indonesia is one of the most biodiverse countries in the world, home to a wide range of ecosystems and a vast number of species of flora and fauna, both terrestrial and marine [1–3]. Unfortunately, the richness of Indonesia's biodiversity has increasingly been degraded [4] due to deforestation, land-use changes, and rising levels of soil, water, and air pollution [5, 6]. Therefore, this vast biodiversity must be balanced through conservation and wise utilization to achieve sustainable development of biodiversity [7]. The greatest challenge in biodiversity and environmental conservation lies in transforming public paradigms and behaviors. For this reason, innovative strategies are needed to ensure effective conservation, one of which is through environmental and conservation education [8].

Within this framework, geography is considered a highly strategic subject for embedding environmental knowledge, values, and behaviors in senior high schools. This is due to geography's spatial, ecological, and regional-complex approaches [9], which are crucial in examining the interrelationships between humans and their environments. Nursa'ban and Mukminan [10] also emphasize that the core of geography is the study of human–environment interactions. Similarly, Hawa et al. [11] affirm that geography is one of the essential disciplines for advancing the education for sustainable development goals (ESD).

In Indonesia's current upper secondary school curriculum, the Merdeka Curriculum (Independent Curriculum), a more flexible, student-centered curriculum focused on essential competencies (literacy, numeracy, and character) through in-depth, project-based learning, geography is no longer a compulsory subject but rather an elective. In 10th grade, geography is taught to all students, with three lessons per week. Then, in 11th and 12th grades, geography is taught only to students taking geography as an elective, with five lessons per week. In 10th grade, the geography syllabus covers basic geographic concepts, maps, remote sensing and geographic information systems, the formation of the Earth, the lithosphere, the atmosphere, and the hydrosphere. Meanwhile, in 11th and 12th grades, the material covers the position and shape of Indonesia's territory, flora and fauna in Indonesia and the world, environmental conservation and sustainable development, population geography, cultural geography, disaster mitigation, spatial planning and development, rural and urban geography, and the use of remote sensing and GIS for regional development.

Given the potential of geography in addressing environmental and developmental challenges, geography education must be delivered in innovative ways that equip students with 21st-century geographical competencies. However, the teaching of geography still faces persistent challenges: it is often dominated by rote memorization [12], relies on monotonous methods, and employs ineffective assessment practices [13]. Therefore, geography teaching requires pedagogical innovations in which teachers move away from conventional, teacher-centered practices toward more responsive approaches that incorporate feedback, guidance, and high-quality support [14].

One pedagogical model that can be applied in geography learning is outdoor study, or fieldwork. Based on the geography syllabus in the Indonesian Curriculum, each topic can be implemented using an outdoor study approach because geography always uses spatial, environmental, and complex regional approaches. Outdoor study refers to learning conducted outside the classroom, where teachers engage students in observing real-world phenomena with the aim of fostering deeper connections with their environment [15]. Outdoor study is also commonly referred to as outdoor learning, outdoor activities, field learning, or learning beyond the classroom. It promotes engaging and enjoyable learning experiences that occur in real contexts, allowing students to directly encounter and interact with the subject matter [16].

The outdoor study model can be further combined with problem-based learning (PBL). PBL is an instructional model in which students collaborate to resolve problems rooted in their immediate environment [17]. It begins with real-world problems observed in the surroundings, enabling students to collect information and integrate it with new knowledge that they construct independently. In implementing PBL, students must actively and fully participate in problem-solving by constructing their own understanding [18].

Problem-based learning becomes most effective when it focuses on contextual issues, since the starting point of PBL is situated in students' real-life experiences [19]. This is closely aligned with contextual learning approaches, which emphasize learners' interests and experiences [20]. Contex-

tual teaching and learning (CTL) integrates academic skills with real-world situations, bridging classroom content with everyday experiences [21]. CTL fosters students' holistic involvement—both physically and mentally—enabling them to connect knowledge with real-life situations and apply it meaningfully in their daily lives [22].

Building on these perspectives, this study combines outdoor study with contextual problem-based learning, resulting in the Geo-Outdoor CPBL model. The primary rationale for this combination is supported by previous research showing its effectiveness: an outdoor study has proven to enhance students' knowledge and spatial intelligence in geography learning [23, 24], while studies on PBL demonstrate its positive impact on learning outcomes in geography [25–27]. Moreover, contextual learning approaches have also been shown to improve student achievement in geography [28]. Based on this background, the present study aims to analyze the effectiveness of the contextual problem-based outdoor study model (Geo-Outdoor CPBL) in enhancing students' critical thinking and ecoliteracy in geography education at the senior high school level.

1.2. Theoretical Background

The Geo-Outdoor Contextual Problem-Based Learning (CPBL) model developed in this study draws upon key educational theories, including Problem-Based Learning (PBL), Contextual Teaching and Learning (CTL), and outdoor education. PBL emphasizes student-centered inquiry through real-world problems that require analysis, synthesis, and evaluation [29]. CTL places learning in a meaningful context that connects academic content to students' life experiences [30]. Outdoor education adds an experiential dimension by placing students in natural or real-world environments where environmental phenomena can be directly observed and explored [31].

Several studies have discussed outdoor studies in geography education, including a literature review by Brookfield [32]. Additionally, there is a study by Saragih et al. [33], Rizaldi et al. [34], Segara et al. [35], and Aksit et al. [36]. Other studies also discuss contextual learning in geography learning, such as those by Pratiwi et al. [37], Lu [38], and Puastuti and Sinthiya [39]. Compared to outdoor study and contextual learning, which have received less research in geography learning, problem-based learning has become a highly researched learning model in geography. Some recent studies related to PBL include those by Wijayanto et al. [40], Wahelo et al. [41], and Fadjarani et al. [42].

Despite these examples, there remains a lack of structured models that systematically integrate contextual, problem-based, and outdoor learning specifically for geography education. The Geo-Outdoor CPBL model addresses this gap by synthesizing these theoretical elements into a coherent instructional design tailored to the geography curriculum. This study does not claim to create a new pedagogical theory, but rather to develop an integrative learning design that contextualizes several existing designs—outdoor study, contextual learning, and problem-based learning—into a coherent model adapted to the geographic and environmental realities of Indonesia. The novelty of this research lies in the integration of various pedagogical approaches into a Geo-Outdoor CPL model, making it more responsive to local ecological contexts and relevant to 21st-century geography education. The pedagogical foundation in this study is built on an existing framework, and the Geo-Outdoor CPBL model contributes a new, contextual adaptation by incorporating the unique geographic setting of Mount Merbabu. This contextualization supports empirical evidence that local environmental engagement can significantly influence the development of critical thinking and ecoliteracy skills.

Conceptually, this research bridges contextual and experiential learning theories with the realities of geography education in Indonesia. Practically, it provides an implementable framework for teachers to cultivate ecoliteracy through authentic environmental engagement. The Geo-Outdoor CPBL framework can be positioned as a distinct conceptual synthesis that bridges contextual, problem-based, and outdoor experiential learning. What differentiates this approach from prior models is the way it operationalizes contextual problem-solving through field-based engagement, situating learning within authentic ecological settings. This synthesis enables students to construct knowledge that is both place-specific and transferable, a dimension rarely emphasized in conventional PBL or CTL approaches.

Conceptually, the integration of these frameworks aligns with the broader discourse on place-based education and education for sustainable development (ESD). The Geo-Outdoor CPBL model provides empirical evidence that grounding learning in local ecological contexts—such as the Merbabu Mountain region—enhances students' environmen-

tal awareness and cognitive engagement. Thus, the model's distinct contribution is its synthesis of experiential and contextual learning principles within a geography-specific framework, offering a meaningful pedagogical bridge between theory and local environmental practice. While not a new theoretical model, Geo-Outdoor CPBL represents a significant contextual and methodological refinement that broadens the practical applicability of existing pedagogical approaches in geography.

2. Materials and Methods

2.1. Research Design

The objectives of this study are to: (1) analyze the Geo-Outdoor CPBL learning model; and (2) analyze the effectiveness of the Geo-Outdoor CPBL learning model in improving students' critical thinking skills. This study employed an experimental design with a quantitative approach. The research utilized a one-group pretest–posttest design. The research procedures consisted of several stages as follows.

2.1.1. Planning Stage

In this stage, the researcher analyzed the existing conditions of geography learning at the research site. The research site was selected purposively based on its strong contextual relevance to geography learning and environmental education. SMA Negeri 1 Getasan is located on the northern slope of Mount Merbabu, Central Java, Indonesia, an area characterized by volcanic landforms, mountainous ecosystems, agricultural land use, and conservation zones. This geographical setting provides authentic environmental phenomena that are highly suitable for implementing outdoor and contextual problem-based learning.

The Geo-Outdoor CPBL model was applied to the geography topic of environmental conservation and sustainable development, which is part of the Indonesian senior high school geography syllabus for Grade 11. The research was conducted during the second semester of the 2024/2025 academic year, specifically between April and May 2025. During this period, lesson plans, learning materials, field observation guidelines, and assessment instruments were prepared and aligned with the Geo-Outdoor CPBL learning syntax. After mapping out the potentials, challenges, and problems encountered, the researcher designed a learning strategy using the Geo-Outdoor CPBL model. The planning process included the preparation of lesson scenarios encompassing learning objectives, learning syntax, time allocation, and learning evaluation. These lesson scenarios were compiled into teaching instruments alongside other instructional materials required for the study.

2.1.2. Implementation Stage

The learning implementation began with a pretest to assess students' abilities prior to the experimental treatment. Following the pretest, the teacher conducted geography instruction using the Geo-Outdoor CPBL model. The experiment followed the model syntax, which consisted of three main parts: introduction, core learning activities, and conclusion. After implementation, a posttest was administered to measure students' abilities following the learning experiment.

2.1.3. Data Analysis Stage

After administering the pretest, experimental treatment, and posttest, the next step was data analysis. This stage aimed to evaluate the effectiveness of the intervention and address the research objectives. The analysis process concluded with the formulation of findings, conclusions, and recommendations.

2.2. Study Group

The study was conducted with a single study group, namely an 11th-grade class at SMA Negeri 1 Getasan (State Senior High School 1 Getasan), Semarang Regency, Central Java Province, Indonesia, consisting of 36 students. The selected class followed the Merdeka Curriculum (Independent Curriculum) and was chosen based on relatively homogeneous performance in geography. SMA Negeri 1 Getasan was selected for several key considerations:

a. Its unique geographical location on the northern slope of Mount Merbabu, with many students residing in the foothill areas, making contextual geography learning highly relevant to their environmental, meteorological, geological, geomorphological, social, cultural, and economic conditions;
b. The school's collaboration with the Mount Merbabu National Park Office, which supports the feasibility of outdoor study activities; and

c. The predominance of classroom-based learning, indicating the need for innovative approaches.

2.3. Research Variables

The main research variables were 1) the effectiveness of the Geo-Outdoor CPBL model, measured through the improvement of students' critical thinking skills between the pretest and posttest, and 2) students' ecoliteracy levels after the application of the Geo-Outdoor CPBL model. Critical thinking skills were assessed based on six key indicators: (1) interpretation, (2) inference, (3) analysis, (4) evaluation, (5) explanation, and (6) self-regulation [43]. Ecoliteracy was measured through a questionnaire assessing human–environment connectedness, including feelings, care, and individual behaviors toward the environment [44, 45].

2.4. Application of the Geo-Outdoor CPBL Model

The implementation of the Geo-Outdoor CPBL learning model was conducted as an integral part of the research methodology. The Geo-Outdoor CPBL model was implemented through six sequential stages. These stages structured the learning activities from the initial classroom phase through outdoor fieldwork and post-learning evaluation. During the content introduction and current issues, students were introduced to environmental conservation issues related to Mount Merbabu National Park through maps, images, and guiding questions. The exploration stage involved direct field observations in selected conservation areas, where students examined environmental conditions and human-environment interactions. Students recorded field observations using structured observation sheets and analyzed their findings collaboratively. Next, in the data analysis and action planning and also presentation stage, students proposed solutions to the identified environmental problems and presented their results in group discussions. Finally, the reflection stage involved guided reflection activities and the administration of a posttest to assess students' critical thinking development.

The Geo-Outdoor CPBL learning model was implemented over four weeks. The first week was devoted to the Introduction and Orientation phase, as well as Content Introduction and Current Issues. The second week was devoted to the exploration phase. The third week was devoted to action planning. The fourth week was devoted to presentation and reflection.

2.5. Data Sources and Collection Techniques

Data were collected through pretest and posttest and questionnaires. The pretest and posttest employed the same assessment instrument to measure changes in students' critical thinking skills. The instrument consisted of 30 multiple-choice items developed by the researchers based on critical thinking indicators. The pretest and posttest score range is from 0 to 100. The test content focused on environmental conservation, with a specific emphasis on conservation issues and environmental management in Mount Merbabu National Park. The contextualization of test items aimed to ensure alignment between learning activities, outdoor field experiences, and assessment outcomes. The pretest was administered prior to the implementation of the Geo-Outdoor CPBL learning model to assess students' initial critical thinking ability related to environmental conservation. The posttest was conducted after the completion of all learning stages to evaluate learning gains resulting from the instructional intervention. The questionnaires were employed to assess students' ecoliteracy after the Geo-Outdoor CPBL implementation. The questionnaire items were developed using a Likert scale. The number of questions in the questionnaire consists of 20 questions.

2.6. Data Analysis

The data analysis techniques included quantitative descriptive analysis to analyze pretest and posttest results and students' ecoliteracy. To determine the effectiveness of the Geo-Outdoor CPBL model, a paired sample *t*-test analysis was conducted. Prior to this test, the normality of the data was examined to ensure that pretest and posttest scores were normally distributed. The data normality tests were performed using both the Kolmogorov–Smirnov and the Shapiro–Wilk methods. Data were considered normally distributed if the significance value exceeded 0.05.

The results of both the Kolmogorov–Smirnov and the Shapiro–Wilk tests confirmed that the students' pretest and posttest scores at SMA Negeri 1 Getasan followed a normal distribution, with significance values above 0.05 in both cases. Thus, the dataset met the assumptions required for conducting the paired sample *t*-test. **Table 1** presents the results of the data normality tests.

Table 1. Results of Normality Tests for Students' Learning Outcomes.

Value	df	Kolmogorov-Smirnov Sig.	Shapiro-Wilk Sig.	Conclusion
Pretest	35	0.06	0.15	Normally distributed
Posttest	35	0.06	0.12	Normally distributed

Source: Data Analysis (2025).

Table 1 shows that all data were found to be normally distributed. The analysis indicated significance values for the pretest data of 0.064 (Kolmogorov–Smirnov) and 0.159 (Shapiro–Wilk), and for the posttest data, 0.068 (Kolmogorov–Smirnov) and 0.123 (Shapiro–Wilk). As all significance values were greater than 0.05, it can be concluded that the data distributions for both groups met the normality assumption. Accordingly, the parametric paired sample *t*-test could be used to assess the differences in mean scores between the pretest and posttest.

Parametric statistical analysis was conducted to ensure more credible research findings. The statistical method employed was a paired sample *t*-test, which was used to determine whether there was a significant difference between students' learning outcomes at the pretest and posttest stages. A statistically significant difference between pretest and posttest scores is an indicator of the effectiveness of the Geo-Outdoor CPBL learning model. The decision criterion was that if the significance value (*p*-value) was less than 0.05, then a significant difference existed between pretest and posttest scores.

After conducting the paired sample *t*-test analysis, a further analysis was performed to determine the extent of improvement in students' learning outcomes following the implementation of the Geo-Outdoor CPBL learning model. While the paired sample *t*-test demonstrated that the Geo-Outdoor CPBL model was effective in enhancing critical thinking skills, it did not reveal the magnitude of this improvement. Therefore, a Normalized Gain (N-Gain) Score analysis was carried out to measure the effectiveness of this instructional intervention in quantitative terms.

3. Results

3.1. The Geo-Outdoor CPBL Learning Model

The Geo-Outdoor CPBL learning model presented in this study is an instructional model developed by the authors through a synthesis and adaptation of several established learning approaches, including Contextual Teaching and Learning[46], Problem-Based Learning[47], outdoor learning[48], and geography-based spatial learning[49, 50]. The model was designed to integrate these theoretical foundations into a structured learning framework that is specifically tailored to geography education and environmental literacy development.

The Contextual Problem-Based Outdoor Study (Geo-Outdoor CPBL) is a learning model that integrates the principles of outdoor study, contextual learning, and problem-based learning. This model facilitates students not only to engage in classroom-based activities but also to learn outside the classroom, where they directly observe and analyze geosphere phenomena in their immediate environment. The approach emphasizes contextual problem solving, encouraging students to identify, analyze, and formulate solutions to real-world geographical and environmental issues.

The development of the Geo-Outdoor CPBL model addresses the challenges of 21st-century geography education, which requires students to acquire critical thinking and problem-solving abilities, creativity, communication, and collaboration. By utilizing the surrounding environment as a meaningful learning resource, the model bridges daily experiences with academic inquiry. The learning process involves both classroom and field-based activities, enabling students to identify real-life environmental problems and devise strategic solutions. Through this process, students engage in deeper critical thinking and creativity, driven by problem-solving tasks that are directly relevant to their lives.

Problem identification and problem-solving activities in the Geo-Outdoor CPBL model are conducted primarily in outdoor settings, thereby enhancing students' field observation and analysis skills. This approach provides valuable hands-on experiences aligned with the principles of fun learning. Students directly engage with observable geosphere phenomena rather than relying solely on theoretical knowledge, thereby strengthening their abilities in observation, identification, and field analysis. Consequently, students learn to uncover real-world problems—such as environmental pol-

lution, land-use change, and ecosystem degradation—and attempt to formulate solutions relevant to their local context.

The Geo-Outdoor CPBL learning model consists of six main syntaxes, spanning the learning process from introduction to conclusion. These are 1) introduction and orientation, 2) content introduction and presentation of current issues, 3) exploration (outdoor study), 4) data analysis and action planning, 5) discussion and presentation, and 6) reflection. These six syntaxes are flexible and can be applied to a wide range of topics in geography education. They are adaptive and accommodative toward diverse learning scenarios, instructional media, and instructional methods within the subject. The syntaxes of the Geo-Outdoor CPBL model are illustrated in **Figure 1** below.

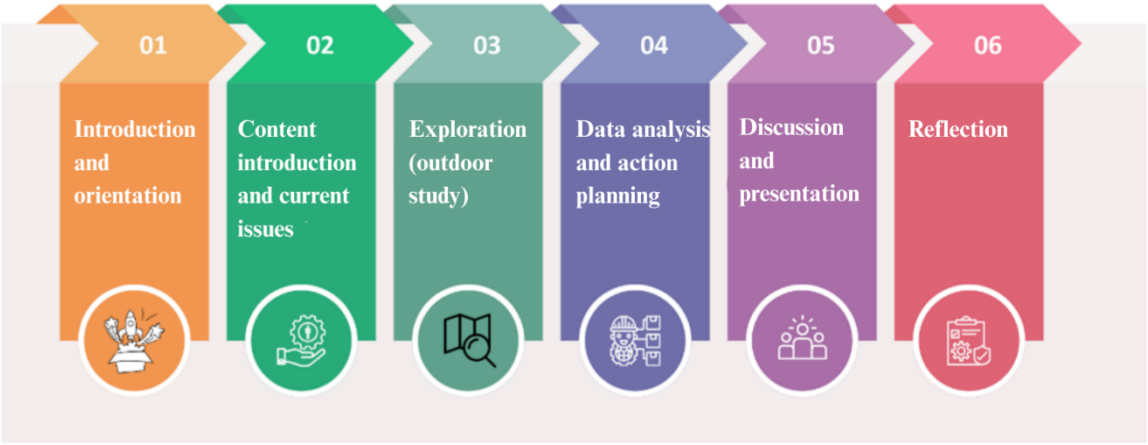


Figure 1. Syntax Model of Geo-Outdoor CPBL.

Source: Developed by the Authors.

In this study, the Geo-Outdoor CPBL learning model was implemented systematically by following its six main syntaxes. Each syntax was operationalized into specific learning activities that integrated classroom instruction, outdoor fieldwork, and problem-based learning tasks related to environmental conservation in Mount Merbabu National Park. Learning activities for each syntax are described in **Table 2** below.

Table 2. Learning Activities in Each Syntax.

No.	Syntax	Learning Activities
1	Introduction and Orientation	Opening learning activities, apperception, and brainstorming.
2	Content Introduction and Current Issues	Teacher introduces environmental issues related to conservation challenges in Mount Merbabu National Park through maps, photos, and local case studies. Students identify key environmental problems (e.g., land degradation, biodiversity loss, tourism pressure) through guided discussion.
3	Exploration (Outdoor Study)	Students conduct field observations in selected conservation areas within Mount Merbabu National Park. Students collect data through observation sheets, field notes, and simple environmental measurements, then analyze findings in groups.
4	Data Analysis and Action Planning	Students conduct data analysis and design an action plan to solve environmental problems in Mount Merbabu National Park.
5	Discussion and Presentation	Students present their findings in group presentations.
6	Reflection	Students reflect on learning experiences and environmental values; teacher conducts evaluation through posttest and reflection discussion.

Source: Developed by the Authors.

3.2. The Effectiveness of the Geo-Outdoor CPBL Model

The implementation of the Geo-Outdoor CPBL model in geography learning was carried out at SMA Negeri 1 Getasan. The application involved three stages: pretest, instructional treatment, and posttest. The pretest was administered to measure students' achievement prior to the intervention, while the posttest evaluated the learning outcomes after the intervention. The results of the two tests were compared to determine whether there was a significant difference, which served as an indicator of the model's effectiveness in improving student learning outcomes.

The implementation of the learning model at SMA Negeri 1 Getasan involved 36 eleventh-grade students enrolled in geography under the Merdeka Curriculum (Independent Curriculum). An analysis of the frequency distribution of pretest scores revealed that the mean pretest score for these students was 41.67. Only one student out of 36 achieved the highest score of 73, while the remaining 35 students scored below the established Minimum Mastery Criterion of 75, with the lowest score being 23. The standard deviation for the pretest scores was 10.108. These results indicate that, prior to the instructional intervention, none of the participants reached the expected mastery standard. This finding suggests that students' initial mastery of the material was low, highlighting the need for effective instructional strategies or interventions to improve learning outcomes. The analysis of both pretest and posttest scores at SMA Negeri 1 Getasan is presented in **Table 3**.

Table 3. Pretest and Posttest Scores of Students at SMA Negeri 1 Getasan.

Stage	N	Min	Max	Mean	Std. Dev.
Pretest	36	23	73	41.67	10.108
Posttest	36	70	97	83.92	6.995

Source: Data Analysis (2025).

Table 3 demonstrates that students' posttest scores were considerably higher than their pretest scores following the application of the Geo-Outdoor CPBL model. There was a marked improvement in the frequency distribution of student performance. Of the 36 participants, 31 students (86.1%) achieved scores above the Minimum Mastery Criterion, while only 5 students (13.9%) remained below. The mean posttest score increased to 83.98, with a range of 70 to 97. Furthermore, the standard deviation decreased substantially from 10.108 (pretest) to 6.995 (posttest), indicating a more homogeneous distribution of scores after the intervention.

Analysis by gender showed that male students obtained higher pretest and posttest scores than female students. The average pretest score for male students was 45, while for female students it was 39. Furthermore, the average posttest score for male students was 88, while for female students it was 81.

The increase in average mastery, from 41.67 to 83.98, indicates that the majority of participants significantly improved their understanding and skills in the material taught. In addition, the number of students who did not meet the Minimum Mastery Criterion (KKM) dropped sharply from 35 to just 5. This demonstrates that the Geo-Outdoor CPBL instructional intervention was effective in helping students comprehend the material and achieve the desired competency standards. From a pedagogical perspective, this shift in score distribution shows that the implementation of the Geo-Outdoor CPBL model accommodated diverse learning styles, provided relevant content, and offered sufficient practice. As a result, students were able to internalize new knowledge effectively, leading to a significant improvement in learning outcomes. The pretest and posttest scores of students at SMA Negeri 1 Getasan are depicted in **Figure 2** below.

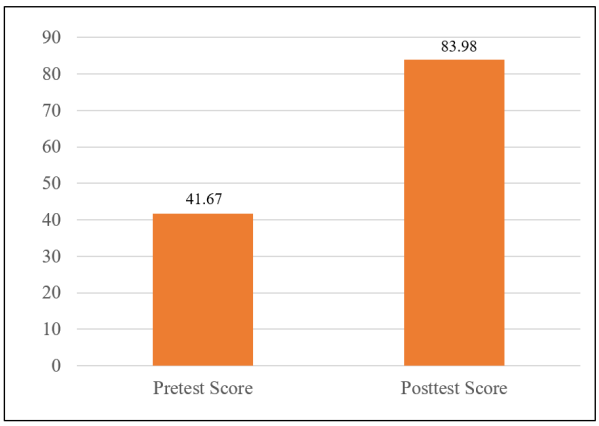


Figure 2. Pretest and Posttest Scores of Students at SMA Negeri 1 Getasan.

Source: Data Analysis (2025).

The effectiveness of the Geo-Outdoor CPBL learning model in this study was assessed by comparing students' learning outcomes between the pretest and posttest stages. The results of the paired sample *t*-test indicated a statistically significant difference ($t(35) = -27.23$, $p < 0.001$). This indicates a significant difference between students' learning outcomes at SMA Negeri 1 Getasan in the pretest and posttest stages. The results confirm the effectiveness of the Geo-Outdoor CPBL model in improving student achievement. The results of the paired sample *t*-test are presented in **Table 4** below.

Based on the N-Gain Score analysis, the average N-Gain Score was found to be 0.73. According to Hake's criteria[51], this value is categorized as high. Accordingly, instruction using the Geo-Outdoor CPBL model resulted in a high level of effectiveness in fostering students' critical thinking skills. The results of the N-Gain Score analysis are presented in **Table 5** and **Figure 3**.

Table 4. Analysis Results of One Paired Sample *t*-Test.

df	*t*	Sig. (*p*-Value)	Conclusion
35	−27.23	0.00	There is a significant difference

Source: Data Analysis (2025).

Table 5. N-Gain Score Analysis.

No.	Pretest	Posttest	N-Gain	Category
1	33	87	0.80	High
2	40	93	0.89	High
3	23	83	0.78	High
4	40	80	0.67	Medium
5	33	77	0.65	Medium
6	27	83	0.77	High
7	30	73	0.62	Medium
8	47	90	0.81	High
9	37	83	0.74	High
10	40	90	0.83	High
11	50	83	0.67	Medium
12	57	77	0.46	Medium
13	33	83	0.75	High
14	43	83	0.71	High
15	47	90	0.81	High
16	33	73	0.60	Medium
17	50	93	0.87	High
18	30	70	0.57	Medium
19	37	73	0.58	Medium
20	50	87	0.73	High
21	27	87	0.82	High
22	43	77	0.59	Medium
23	47	80	0.63	Medium
24	57	90	0.77	High
25	43	87	0.76	High
26	40	93	0.89	High
27	37	83	0.74	High
28	40	80	0.67	Medium
29	43	73	0.53	Medium
30	40	77	0.61	Medium
31	53	90	0.79	High
32	73	97	0.88	High
33	43	90	0.82	High
34	37	83	0.74	High
35	57	90	0.77	High
36	40	93	0.88	High

Table 5. *Cont.*

No.	Pretest	Posttest	N-Gain	Category
Average	42	84	0.73	High

Source: Data Analysis (2025).

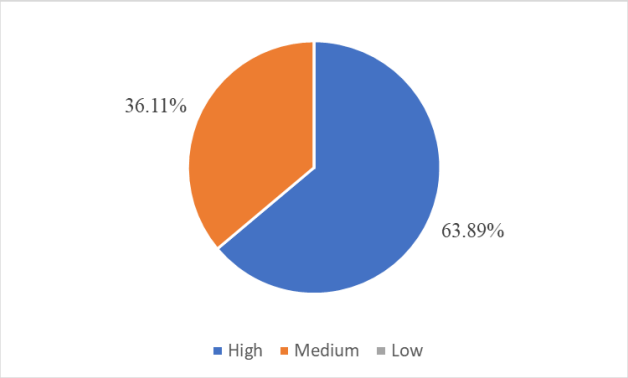


Figure 3. N-Gain Score.

Source: Data Analysis (2025).

3.3. Ecoliteracy Levels after the Implementation of Geo-Outdoor CPBL

Ecoliteracy was measured as part of the learning outcomes using the Geo-Outdoor CPBL model. This is because the Geo-Outdoor CPBL model is expected to not only improve students' critical thinking skills but also foster a love and care of the environment. Students' scores were categorized into different eco-literacy levels to illustrate changes in their environmental care attitude and behavior after the implementation of the Geo-Outdoor CPBL model.

Figure 4 presents the eco-literacy level analysis, which illustrates the distribution of students' eco-literacy levels after the implementation of the Geo-Outdoor CPBL learning model. The descriptive statistical analysis of the 36 participants indicated an average ecoliteracy score of 80.92, with the overall mean score centered at 83.00. This clustering around the mean suggests that most participants achieved relatively uniform scores. The standard deviation of 5.623 further confirms that the variation in ecoliteracy levels across individuals was minimal, implying homogeneity in students' abilities. The lowest ecoliteracy score recorded was 59, while the highest was 89. Despite some degree of variation across individuals, these figures indicate that the overall ecoliteracy level of the students can be classified as relatively high—as can be seen in **Figure 4**.

The distribution analysis shows that only one participant (2.8%) fell into the "moderate" ecoliteracy category. Meanwhile, 26 participants (72.2%) were placed in the "high" category, and 9 participants (25.0%) were categorized as "very high." This distribution highlights that the majority of students have developed strong levels of environmental understanding, awareness, and pro-environmental behavior, including conceptual knowledge, positive attitudes, and environmentally friendly practices.

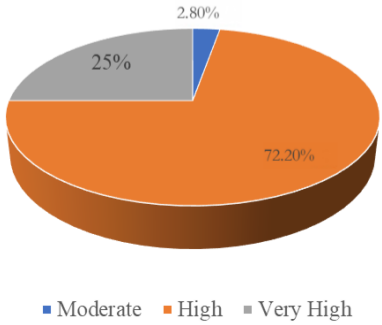


Figure 4. Results of Ecoliteracy Level Analysis.

Source: Data Analysis (2025).

The dominance of the "high" and "very high" categories suggests that overall, the participants had already achieved considerable ecoliteracy competencies. The small proportion of students in the "moderate" category also indicates the potential for targeted interventions focused on this group. Such efforts could ensure that all students progress to the "high" or "very high" ecoliteracy categories, thereby strengthening the collective ecological competencies of the entire group.

4. Discussion

The implementation of the Geo-Outdoor CPBL learning model in this study combined direct field experiences with contextual problem solving relevant to students' daily lives. The findings of this study demonstrate that the implementation of the Geo-Outdoor Contextual Problem Based Learning (Geo-Outdoor CPBL) model resulted in a significant improvement in students' geography learning outcomes.

The increase in post-test scores compared to pretest scores, supported by a high N-Gain value, indicates that students were able to construct a deeper understanding of geographical concepts after participating in learning activities that integrated contextual problems and outdoor field experiences.

This improvement suggests that learning processes that directly engage students with real-world environmental phenomena can enhance conceptual understanding more effectively than conventional classroom-based instruction. Through direct observation and problem exploration in authentic settings, students were encouraged to actively analyze spatial relationships, environmental interactions, and human–environment dynamics, which are core components of geographical thinking.

These findings are consistent with previous studies that reported by utilizing the school environment as an authentic learning resource, outdoor-based learning significantly enhanced academic achievement, social skills, and motivation[52–54]. Local outdoor learning activities provided opportunities to strengthen both critical thinking and ecoliteracy[55]. Moreover, contextual learning integrated with problem-based learning (PBL) has been shown to reinforce conceptual understanding through active student engagement[56].

The practical application of the Geo-Outdoor CPBL model engaged students with authentic geographical issues in their environment, such as the dynamics of the Mount Merbabu slopes. This approach allowed students to experience meaningful and contextualized learning. These findings are also consistent with previous studies that indicate that contextual teaching and learning (CTL) has a significant impact on students' outcomes[57], and the integration of PBL strengthens critical thinking and problem-solving across disciplines[58]. Similarly, Mardani et al.[59] emphasized that PBL promotes active exploration, deeper conceptual understanding, greater motivation, and stronger communication skills. More recent studies, such as Nurfadilah et al.[60], confirm that hybrid-PBL in geography learning enhances critical thinking and academic performance. Collectively, these findings support the argument that outdoor study combined with contextual PBL is a relevant and effective strategy for developing 21st-century geography competencies.

The effectiveness of the Geo-Outdoor CPBL model was evident from the significant increase in students' average achievement scores. This is relevant to the notion that learning in natural environments correlates positively with academic outcomes and social skill development[61]. Kuo et al.[54] also highlight that learning outdoors encourages active and collaborative engagement, which contributes to improved cognitive performance. Moreover, contextual environmental learning, when integrated with PBL, strengthens cognitive skills and boosts student motivation[58]. The findings of this study confirm that the model is effective in raising both achievement levels and equity in learning outcomes. The sharp increase in students achieving minimum mastery suggests that the model not only improves average performance but also minimizes achievement gaps. This aligns with earlier findings showing that contextual approaches reconstruct students' knowledge and skills from real-world experiences, and that outdoor learning strengthens spatial awareness—an essential competence in contemporary geography education[62, 63]. However, the present study extends existing research by demonstrating that the integration of outdoor study with contextual problem-based learning in a real conservation area provides added value to geography instruction. Unlike studies that primarily focus on simulated or classroom-based contexts, this research shows that authentic environmental settings can serve as powerful learning resources for improving students' learning outcomes.

The results of this study also reveal that students' ecoliteracy levels reached a high category following the implementation of the Geo-Outdoor CPBL model. This finding indicates that the learning experiences provided through outdoor exploration and contextual problem-solving were effective in fostering students' awareness, understanding, and concern for environmental issues. The increase in ecoliteracy can be attributed to the model's emphasis on direct interaction with environmental problems. By engaging with real ecological conditions, students were not only exposed to environmental concepts but also encouraged to reflect on human responsibility toward environmental sustainability. Such learning experiences appear to promote a more holistic understanding of environmental issues that encompasses cognitive, affective, and behavioral dimensions. The improvement in ecoliteracy in students after implementing the learning model shows that place-based learning experiences are crucial for developing ecological awareness.

This finding aligns with prior research highlighting

that learning in a contextually based PBL environment can significantly improve students' ecological knowledge, ecological attitudes, and ecological actions [64]. Understanding ecology encourages and equips students to think critically about their environment and improves their problem-solving skills related to environmental sustainability [65]. Learning in a contextually based environment has also been shown to strengthen environmental thinking and literacy skills [55], thereby fostering environmental awareness in students and effectively shaping pro-environmental attitudes [53]. The outdoor study model allows students to interact directly with the local ecosystem. This aligns with the experiential learning framework, where such authentic experiences can improve knowledge, attitudes, and intentions in pro-environmental behavior [66, 67]. These findings confirm that a model that combines field learning with real-world problem-solving has proven effective in improving ecoliteracy and students' cognitive abilities related to environmental issues [68]. Furthermore, increasing ecoliteracy will be more impactful if followed up through concrete actions, habituation of environmentally friendly behavior in schools, and integration across subjects or extracurricular activities that correlate with environmental problem-solving skills and environmentally conscious behavior [69, 70].

The dominance of "high" and "very high" ecoliteracy categories among students indicates that most already possess a strong basis for pro-environmental behavior. This is closely linked to appropriate pedagogical interventions that foster pro-environmental behavior (PEB) in students [71]. Other research also emphasizes that outdoor experiential learning contributes significantly to shaping sustainable behavior [72] and that strong environmental literacy motivates involvement in sustainability initiatives [70]. Furthermore, field-based learning opportunities that integrate problem-solving train students to identify, analyze, and design solutions to environmental challenges [73]. Therefore, the integration of outdoor study and contextual PBL in this study proved not only to enhance knowledge and skills but also to support the formation of long-term ecological behavior. Overall, the Geo-Outdoor CPBL model has strong potential to improve ecoliteracy, which is an essential competency for the 21st century.

The integration of digital technology—particularly Geographic Information Systems (GIS)—offers considerable potential to strengthen the Geo-Outdoor CPBL model. Incorporating GIS-based applications such as Google Earth, QGIS, or mobile mapping tools can enhance students' field experiences by enabling real-time spatial data collection, environmental monitoring, and spatial pattern analysis. These technologies support critical thinking by allowing learners to visualize and interpret geospatial phenomena, thereby bridging field observations with digital analytical skills. The inclusion of digital mapping and data-sharing platforms also fosters collaboration and reflection, aligning Geo-Outdoor CPBL with the digital transformation of education and the journal's pedagogical–technological focus. In this regard, GIS integration not only enriches the model's instructional design but also extends its relevance to tech-enhanced geography learning.

Beyond its initial implementation in the Mount Merbabu context, the Geo-Outdoor CPBL model holds strong potential for adaptation to other environmental settings such as coastal ecosystems, urban environments, or disaster-prone areas. Each of these contexts presents distinct geographical challenges that can be transformed into authentic learning problems for students. By adjusting the contextual problem base—while maintaining the core integration of outdoor, contextual, and problem-based learning—the model can cultivate ecoliteracy and critical thinking across diverse ecological domains. Such adaptability underscores the model's scalability and its contribution to education for sustainable development, as it enables geography educators to contextualize learning according to local environmental dynamics and sustainability priorities. Besides that, geography teaches about geosphere phenomena, including the atmosphere, lithosphere, hydrosphere, biosphere, and anthroposphere, using spatial, environmental, and complex regional approaches. All material in the geography curriculum can be taught using outdoor study methods.

5. Conclusions

This study demonstrates that the Geo-Outdoor Contextual Problem Based Learning (Geo-Outdoor CPBL) model is effective in improving students' learning outcomes in geography. The results show a significant increase in students' posttest scores compared to pretest scores, indicating that the integration of contextual problem-solving and outdoor

learning activities enhances students' understanding of geographical concepts. In addition to improving learning outcomes, the implementation of the Geo-Outdoor CPBL model also contributes positively to the development of students' ecoliteracy. Students who participated in outdoor-based and contextual learning activities demonstrated high levels of environmental awareness and understanding, suggesting that direct engagement with real environmental issues fosters meaningful learning experiences.

The contribution of the Geo-Outdoor CPBL contribution lies not in introducing a new pedagogical theory but in the integration and contextual adaptation of established frameworks to the realities of geography education. By embedding problem-based and contextual learning principles into outdoor field experiences, this study provides an innovative and locally grounded instructional approach. The Geo-Outdoor CPBL model thereby extends the practical scope of geography pedagogy, supporting teachers in fostering 21st-century competencies and environmental awareness through authentic learning. Conceptually, this study bridges experiential and contextual learning theories, offering a model that can be replicated or adapted across diverse geographical settings. Practically, it provides a framework for geography educators to enhance ecoliteracy and problem-solving skills through field-based, student-centered learning.

Despite its promising results, this study has several limitations. First, methodologically, this study employed a one-group pretest–posttest design without a control group, which limits causal inferences about the intervention's effectiveness. It was conducted in a single school with a limited sample size, which constrains the generalizability of the findings. Second, the short study duration did not allow examination of the long-term impacts of the model on students' attitudes and behaviors. Third, the research instruments focused primarily on cognitive tests and questionnaires, while qualitative approaches such as field observations or in-depth interviews were not employed. Furthermore, the implementation of the model was closely tied to specific environmental and geographical characteristics of the study site, which may influence its applicability in different educational and ecological contexts.

Future research could address these limitations by expanding the scope to include more schools in diverse geographical contexts, adopting quasi-experimental or mixed-method designs for more comprehensive insights, incorporating control and comparison groups across different schools to validate the model's generalizability, and conducting longitudinal studies to assess long-term impacts on students' behavior, attitudes, and environmental awareness. Potential locations for applying the Geo-Outdoor CPBL model include coastal environments (e.g., the North Coast of Java or the South Coast of Java), volcanic and mountainous areas (e.g., Mount Merapi, Dieng Plateau, Mount Bromo–Tengger area), karst landscapes (e.g., Gunung Sewu Geopark), watershed systems (e.g., the Bengawan Solo or Brantas watersheds), and urban environmental contexts (e.g., riverbanks, urban green spaces, and flood-prone areas in cities such as Semarang, Jakarta, or Surabaya). These diverse environments provide rich and authentic contexts for geography learning and environmental problem analysis.In addition, exploring the application of the Geo-Outdoor CPBL model in other disciplines that deal with real-world phenomena may broaden its contribution to innovative educational practices.

Author Contributions

S. conceived and designed the study, conducted the data collection and analysis, and drafted the manuscript. M.S. and E.K. supervised the research design, provided theoretical and methodological guidance, and contributed to the manuscript review and editing. A.I.B. provided critical feedback and contributed to the refinement of the research discussion and conclusions. All authors read and approved the final version of the manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The study was fully funded by the author's personal resources.

Institutional Review Board Statement

Ethical review and approval were waived for this study because it involved minimal risk and was conducted in collaboration with the participating school. The study also followed ethical standards of educational research, with prior permission from the school administration.

Informed Consent Statement

Informed consent was obtained verbally from the participating students and formally from the school authorities prior to the implementation of the outdoor learning activities. All participants were informed about the research objectives and assured of confidentiality.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical considerations involving student participants.

Acknowledgments

The authors would like to express sincere gratitude to the teachers and students of SMA Negeri 1 Getasan for their participation and enthusiasm during the outdoor learning activities. Special thanks are also extended to the staff of Mount Merbabu National Park Office for their guidance and support during the field study. The authors appreciate the administrative and technical assistance provided by the Faculty of Social and Political Sciences, Universitas Negeri Semarang, throughout the research process.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Siboro, T.D., 2019. Benefits of biodiversity to the environment. Jurnal Ilmiah Simantek. 3(1), 1–4. (in Indonesian)

[2] Hutomo, M., Moosa, M.K., 2005. Indonesian marine and coastal biodiversity: Present status. Indian Journal of Marine Sciences. 34(1), 88–97.

[3] Sasai, Y., Miyazawa, Y., Nadaoka, K., et al., 2011. Marine ecosystem simulation in the Indonesian seas. In: Omori, K., Guo, X., Yoshie, N. et al. (Eds.). Interdisciplinary Studies on Environmental Chemistry—Marine Environmental Modeling & Analysis. TERRAPUB: Tokyo, Japan. pp. 11–17.

[4] Maskun, Assidiq, H., Al Mukarramah, N.H., et al., 2021. Threats to the sustainability of biodiversity in Indonesia by the utilization of forest areas for national strategic projects: A normative review. IOP Conference Series: Earth and Environmental Science. 886, 012071. DOI: https://doi.org/10.1088/1755-1315/886/1/012071

[5] Arifin, H.S., Nakagoshi, N., 2011. Landscape ecology and urban biodiversity in tropical Indonesian cities. Landscape and Ecological Engineering. 7, 33–43.

[6] Nugroho, H.Y.S.H., 2023. A chronicle of Indonesia's forest management: A long step towards environmental sustainability and community welfare. Land. 12(6), 1238.

[7] Ministry of Environment and Forestry (KLHK) of the Republic of Indonesia, 2014. The Fifth National Report of Indonesia to the Convention on Biological Diversity. KLHK: Jakarta, Indonesia.

[8] Feszterova, M., Jomova, K., 2015. Character of Innovations in Environmental Education. Procedia–Social and Behavioral Sciences. 197, 1697–1702.

[9] Daldjoeni, N., 2014. Introduction to Geography. Penerbit Ombak: Yogyakarta, Indonesia. (in Indonesian)

[10] Nursa'ban, M., Mukminan, 2023. The implementation of geography learning with spatial representation using the discrepancy evaluation model. REID (Research and Evaluation in Education). 9(1), 49–64. DOI: https://doi.org/10.21831/reid.v9i1.53505

[11] Hawa, N.N., Zakaria, S.Z.S., Razman, M.R., et al., 2021. Geography education for promoting sustainability in Indonesia. Sustainability. 13(8), 4340. DOI: https://doi.org/10.3390/su13084340

[12] Gantait, B., 2022. Problems of geography teaching in Indian Schools: Some reflections. Bhavaveena. 19(1), 118–125.

[13] Utami, D., Haryono, E., 2021. Teacher constraints in implementing authentic assessment of geography learning in Bandar Lampung State High School. Spatial: Wahana Komunikasi dan Informasi Geografi. 21(1), 37–44. Available from: http://repository.lppm.unila.ac.id/31096/1/Jurnal%20UNJ%20kendala%20guru.pdf

[14] Beneker, T., van der Schee, J., 2015. Future geographies and geography education. International Research in Geographical and Environmental Education. 24(4), 287–293.

[15] Husamah, 2013. Pembelajaran Luar Kelas (Outdoor Learning). Prestasi Pustaka: Jakarta, Indonesia. (in Indonesian)

[16] Sejati, A.E., Nasarudin, Ikhsan, F.A., 2020. The effect of outdoor study to the students activeness in senior high school. Geographica: Science & Education Journal. 1(1), 7–12.

[17] Munawaroh, B., Masruri, M.S., 2019. The effectiveness of problem based learning and discovery learning model toward learning outcome in geography on students with external locus of control. Geosfera Indonesia. 4(1), 56–62.

[18] Fitriyanti, Farida, Zikri, A., 2020. Improving students'

scientific thinking attitudes and abilities through the PBL model in Elementary Schools. Jurnal Basicedu. 4(2), 491–497. DOI: https://doi.org/10.31004/basicedu.v4i2.376 (in Indonesian)

[19] Kilroy, D.A., 2004. Problem based learning. Emergency Medicine Journal. 21(4), 411–413.

[20] Satriani, I., Gunawan, M.H., Emilia, E., 2012. Contextual teaching and learning approach to teaching writing. Indonesian Journal of Applied Linguistics. 2(1), 10–22.

[21] Baker, E.L., Hope, L., Karandjeff, K., 2009. Contextualized teaching and learning: A faculty primer. The RP Group Center for Student Success.

[22] Kurniawati, M., 2020. The effectiveness of contextual learning in financial mathematics problem for senior high school. Journal of Mathematical Pedagogy (JoMP). 1(2), 47–53.

[23] Amaluddin, L.O., Rahmat, Surdin, et al., 2019. The effectiveness of outdoor learning in improving spatial intelligence. Journal for the Education of Gifted Young Scientists. 7(3), 717–730. DOI: http://dx.doi.org/10.17478/jegys.613987

[24] Putra, E., 2022. The effectiveness of outdoor study methods in developing students' spatial intelligence in geographic learning. Journal of Geography Science and Education. 4(2), 39–48.

[25] Hasanah, U., Astawa, I.B.M., Citra, I.P.A., 2023. Implementation of the Problem Based Learning Model in geography learning to develop 21st century learning skills in students at SMA Negeri 1 Taliwang. Jurnal Pendidikan Geografi Undiksha. 11(1), 11–17. DOI: https://doi.org/10.23887/jjpg.v11i1.52424 (in Indonesian)

[26] Aristin, N.F., Hastuti, K.P., Arisanty, D., et al., 2023. Effectiveness of problem-based learning models to improve learning outcomes of geography in the new normal learning era. Journal of Education and Learning (EduLearn). 17(4), 623–632.

[27] Putra, U.S., Masruri, M.S., 2019. The effectiveness comparison between inquiry and problem based learning towards geography learning outcomes. Geosfera Indonesia. 4(2), 146–163.

[28] Arisanty, D., Aristin, N.F., Nasrullah, M., 2017. Implementation of Contextual Teaching and Learning (CTL) to improve the geography learning outcomes. Advances in Social Science, Education and Humanities Research. 100, 233–235.

[29] Su, T., Liu, J., Meng, L., et al., 2025. The effectiveness of problem-based learning (PBL) in enhancing critical thinking skills in medical education: A systematic review and meta-analysis. Frontiers in Education. 10, 3389. DOI: https://doi.org/10.3389/feduc.2025.1565556

[30] Fawaas, M.A.H.A., Mustofa, Z., Daryono, R.W., 2024. The Effectiveness of Contextual Teaching and Learning (CTL) and Project Based Learning (PJBL) Methods on Student Learning Outcomes. IJORER : International Journal of Recent Educational Research. 5(4), 1040–1053. DOI: https://doi.org/10.46245/ijorer.v5i4.635

[31] Mundilarto, Pamulasari, H.E., 2017. Outdoor Learning Model through Fieldwork to Improve Physics Achievement in Dynamic Fluid. Journal of Turkish Science and Education. 14(3), 73–86.

[32] Brookfield, K., 2022. 'Nature-enhanced learning' and geography education. Journal of Geography in Higher Education. 46(3), 327–342. DOI: https://doi.org/10.1080/03098265.2021.1926938

[33] Saragih, K.W., Chandra, S., Saragih, S.R., 2025. The effectiveness of outdoor learning-based teaching in enhancing the understanding of geographic concept. Cakrawala: Journal of Citizenship Teaching and Learning. 3(1), 41–48.

[34] Rizaldi, B., Pargito, Sinaga, R.M., 2024. Geo-Activity Learning: Apply Outdoor Study Based on an Ecological Approach to Environmental Literacy. International Journal of Educational and Life Sciences. 2(5), 533–546. DOI: https://doi.org/10.59890/ijels.v2i5.1916

[35] Segara, N.B., Suprijono, A., Marzuqi, M.I., 2023. Outdoor Learning Model by Utilizing Mount Penanggungan Cultural Heritage to Realize Education for Sustainable Development. Indonesian Journal of Educational Research and Review. 6(2), 356–371. DOI: https://doi.org/10.23887/ijerr.v6i2.58892

[36] Aksit, S., Aksit, F., Kayacilar, C., 2012. Geography teaching: without walls. Procedia–Social and Behavioral Sciences. 46, 4487–4492. DOI: https://doi.org/10.1016/j.sbspro.2012.06.282

[37] Pratiwi, R.T., Nungrum, E., Triana, I.J., 2025. Students' and teachers' perception on the implementation of contextual learning based on local potential: A case study of economic geography in Cirebon Regency. Jurnal Geografi Gea. 25(2), 147–159. DOI: https://doi.org/10.17509/gea.v25i2.85978

[38] Lu, C., 2023. Contextual scaffolding in secondary geography education: A lesson study of the instruction of "The Middle East". Science Insights Education Frontiers. 16(1), 2435–2444.

[39] Puastuti, D., Sinthiya, I.A., 2021. A contextual approach to geography learning in school. JLCEdu (Journal of Learning and Character Education). 1(2), 83–90.

[40] Wijayanto, B., Sumarmi, Utomo, D.H., et al., 2023. Problem-based learning using e-module: Does it effect on student's high order thinking and learning interest in studying geography? Journal of Technology and Science Education. 13(3), 613–631. DOI: https://doi.org/10.3926/jotse.1965

[41] Wahelo, T.T., Mengistu, D.A., Merawi, T.M., 2025. Geography teachers' implementation of problem-based learning for deforestation and climate change education in Metekel Zone Secondary Schools, Northwest,

Ethiopia. International Journal of Educational Development. 117, 103314. DOI: https://doi.org/10.1016/j.ijedudev.2025.103314

[42] Fadjarani, S., As'ari, R., Putri, A.E., 2024. Model of Problem-Based Learning in Geography: Focusing on Societal Dynamics to Enhance Spatial Thinking Skills. E3S Web of Conferences. 600, 02011. DOI: https://doi.org/10.1051/e3sconf/202460002011

[43] Hamdani, M., Prayitno, B.A., Karyanto, P., 2019. The ImproveAbility to Think Critically through the Experimental Method. Proceeding Biology Education Conference. 16(1), 139–145. (in Indonesian)

[44] Mayer, F.S., Frantz, C.M., 2004. The connectedness to nature scale: A measure of individuals' feeling in community with nature. Journal of Environmental Psychology. 24(4), 503–515.

[45] Nisbet, E.K., Zelenski, J.M., Murphy, S.A., 2009. The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. Environment and Behavior. 41(5), 715–740.

[46] Dewey, J., 1986. Experience and Education. The Educational Forum. 50(3), 241–252. DOI: https://doi.org/10.1080/00131728609335764

[47] Barrows, H.S., 1996. Problem-based learning in medicine and beyond: A brief overview. New Directions for Teaching and Learning. 1996(68), 3–12. DOI: https://doi.org/10.1002/tl.37219966804

[48] El-Aasar, M., Shafik, Z., Abou-Bakr, D., 2024. Outdoor learning environment as a teaching tool for integrating education for sustainable development in kindergarten, Egypt. Ain Shams Engineering Journal. 15(4), 102629. DOI: https://doi.org/10.1016/j.asej.2024.102629

[49] Bednarz, R.S., Bednarz, S.W., 2008. The Importance of Spatial Thinking in an Uncertain World. In: Sui, D.Z. (Ed.). Geospatial Technologies and Homeland Security: The GeoJournal Library, Vol 94. Springer: Dordrecht, The Netherlands. pp. 315–330. DOI: https://doi.org/10.1007/978-1-4020-8507-9_16

[50] Hickman, J., 2023. Spatial thinking and GIS: Developing and assessing student competencies. International Research in Geographical and Environmental Education. 32(2), 140–158. DOI: https://doi.org/10.1080/10382046.2022.2138172

[51] Hake, R.R., 1998. Interactive-Engagement Methods in Introductory Mechanics Courses. Journal of Physics Education Research. Available from: https://web.archive.org/web/20060607150837/http://www.physics.indiana.edu/~sdi/IEM-2b.pdf

[52] Vasilaki, M.-M., Zafeiroudi, A., Tsartsapakis, I., et al., 2025. Learning in nature: A systematic review and meta-analysis of outdoor recreation's role in youth development. Education Sciences. 15(3), 1–19. DOI: https://doi.org/10.3390/educsci15030332

[53] Mann, J., Gray, T., Truong, S., et al., 2022. Getting out of the classroom and into nature: A systematic review of nature-specific outdoor learning on school children's learning and development. Frontiers in Public Health. 10, 877058. DOI: https://doi.org/10.3389/fpubh.2022.877058

[54] Kuo, M., Barnes, M., Jordan, C., 2019. Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. Frontiers in Psychology. 10, 305. DOI: https://doi.org/10.3389/fpsyg.2019.00305

[55] Setiawan, F.A., Saputra, A.N., 2022. Outdoor learning to improve the wetland ecological literacy of geography education students. Geosfera Indonesia. 7(1), 72–84.

[56] Melesse, D., Menkir, S., Yemata, G., et al., 2025. Effect of context-based instructional approach on students' science process skills acquisition in environmental concepts. Education Inquiry. 1–17. DOI: https://doi.org/10.1080/20004508.2025.2453256

[57] Burhan, H.L., Asrizal, 2023. Meta-analysis: The effect of contextual teaching and learning (CTL) learning model on student skills. Journal of Innovative Physics Teaching. 1(2), 136–145. DOI: https://doi.org/10.24036/jipt/vol1-iss2/25

[58] Tursynkulova, E., Madiyarov, N., Sultanbek, T., et al., 2023. The effect of problem-based learning on cognitive skills in solving geometric construction problems: A case study in Kazakhstan. Frontiers in Education. 8, 3389. DOI: https://doi.org/10.3389/feduc.2023.1284305

[59] Mardani, N.K., Atmadja, N.B., Suastika, I.N., 2021. The influence of the problem based learning (PBL) learning model on motivation and social studies learning outcomes. Jurnal Pendidikan IPS Indonesia. 5(1), 55–65. DOI: https://doi.org/10.23887/pips.v5i1.272 (in Indonesian)

[60] Nurfadilah, Nurvita, Wedhiana, I.K., et al., 2025. The influence of problem-based learning on critical thinking skills in geography learning at SMAN 7 Palu. Jurnal Pendidikan Ilmu Pengetahuan Sosial Indonesia. 10(1), 45–58. (in Indonesian)

[61] Backer, C., Lauterbach, G., Spengler, S., et al., 2017. Effects of regular classes in outdoor education settings: A systematic review on students' learning, social and health dimensions. International Journal of Environmental Research and Public Health. 14(5), 485. DOI: https://doi.org/10.3390/ijerph14050485

[62] Rosita, L., Sumarmi, Astina, I.K., et al., 2025. Enhancing enjoyable learning in geography education through field trips to wetland ecosystems: A mixed-method study. Educational Process: International Journal. 14, e2025073. DOI: https://doi.org/10.22521/edupij.2025.14.73

[63] Listiqowati, I., 2025. Spatial thinking in geography learning in the digital era 4.0 from the perspective of educational philosophy. Jurnal Pendidikan Geosfer. 10(1), 187–203. DOI: https://doi.org/10.24815/jpg.v10i1.

47063 (in Indonesian)

[64] Saputra, T.A., Baharudin, Afriyadi, M.M., 2025. Implementation of environmental education in elementary schools in building students' ecological awareness from an early age: A case study of SD Alam Lampung. Muallimun: Jurnal Kajian Pendidikan dan Keguruan. 5(1), 1–21. DOI: https://doi.org/10.23971/muallimun.v5i1.10007 (in Indonesian)

[65] Juanda, Djumingin, S., Mantasiah, R., et al., 2024. Ecoliteracy digital short stories among students in Indonesia. Journal of Turkish Science Education. 21(2), 254–270. DOI: https://doi.org/10.36681/tused.2024.014

[66] Hayati, R.S., 2020. Environmental education based on experiential learning to improve environmental literacy. Humanika: Kajian Ilmiah Mata Kuliah Umum. 20(1), 63–82. DOI: https://doi.org/10.21831/hum.v20i1.29039 (in Indonesian)

[67] Muqtadir, A.R., Hardi, O.S., Kusumawati, L., 2023. The Influence of Problem-Based Learning Models and Outdoor Learning Methods on Students' Cognitive Abilities. Jurnal Pendidikan Geografi Undiksha. 12(1), 70–82. DOI: https://doi.org/10.23887/jjpg.v12i01.68442

[68] Suryawati, E., Suzanti, F., Zulfarina, et al., 2020. The implementation of local environmental problem-based learning student worksheets to strengthen environmental literacy. Jurnal Pendidikan IPA Indonesia. 9(2), 169–178. DOI: https://doi.org/10.15294/jpii.v9i2.22892

[69] Aulia, A.T., Aji, A., Sriyanto, et al., 2023. The relationship between environmental literacy and the ability to solve environmental problems in students at Adiwiyata School, SMA N 4 Semarang. Edu Geography. 11(3). DOI: https://doi.org/10.15294/edugeo.v11i2.69710 (in Indonesian)

[70] Yusnia, Y., Rizki, N., Tarmizi, P., et al., 2025. The Relationship between the Adiwiyata Program and Environmental Literacy of Students at SDN 02 Bengkulu City. Social, Humanities, and Educational Studies (SHES): Conference Series. 8(3), 2138–2144. (in Indonesian)

[71] Świątkowski, W., Surret, F.L., Henry, J., et al., 2024. Interventions promoting pro-environmental behaviors in children: A meta-analysis and a research agenda. Journal of Environmental Psychology. 96, 102295. DOI: https://doi.org/10.1016/j.jenvp.2024.102295

[72] Juniasih, N.L., Riastini, P.N., 2024. The problem based learning model with outdoor learning variations on the problem-solving abilities of fifth grade elementary school students. Journal of Education Action Research. 8(3), 427–434. DOI: https://doi.org/10.23887/jear.v8i3.78774 (in Indonesian)

[73] Ardoin, N.M., Bowers, A.W., 2020. Early childhood environmental education: A systematic review of the research literature. Educational Research Review. 31, 10353. DOI: https://doi.org/10.1016/j.edurev.2020.100353