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Case method versus project-based learning: Effects on students' ecological literacy

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ABSTRACT

Learning in schools has not yet effectively utilized appropriate learning models, leading to low reasoning abilities and critical thinking skills among students, particularly in environmental literacy. Therefore, the appropriate learning models to solve these problems are the case method and project-based learning. This study aims to ascertain differences in ecological literacy skills between high and low ecological literacy levels using the case method and project-based learning, and to examine whether there is an interaction effect between learning models and ecological literacy skills. This study uses a quasi-experimental design. The population in this study consisted of 90 fourth-grade students at a public school. The sample used consisted of 60 students, selected using random sampling. The research results showed that the project-based learning strategy had a higher average ecological literacy score than students taught using the case method learning ($F = 20.067$; p-value = 0.000 < 0.05). A noteworthy interplay between learning techniques was observed (case-based and project-based learning) and ecological literacy ability (high and low) on ecological literacy ($F = 9.127$; p-value = 0.004 < 0.05). Ecological literacy ability with the case method learning strategy was lower compared to the project-based learning strategy at both high and low ecological literacy levels. In conclusion, to get the most out of learning, teachers should use project-based learning methods that fit their students' ecological literacy levels.

INTRODUCTION

The twenty-first century is a time of transition in education. There will be significant changes in a number of areas in the twenty-first century that will affect education. Critical thinking, problem-solving abilities, creativity, communication, and teamwork are all emphasized in 21st-century education (Fitri et al., 2018). Teachers must be able to adjust to workplace developments and technological advancements in order to educate in the twenty-first century. Teachers need several key competencies, including the 6C idea, to meet the challenges of the twenty-first century. The six C's are Citizenship, Character, Communication, Critical Thinking, and Collaboration (Institut Aminuddin Baki, 2020). Conventional classroom learning is no longer suitable for 21st-century education because it leads to low levels of reasoning and critical thinking among students (Fitri et al., 2018). It even has a negative impact on low student literacy, especially environmental literacy. Teachers should be able to internalize an understanding and caring attitude toward the environment in every learning activity. Learning that involves environmental knowledge prepares students to work smartly and wisely with nature (Sari et al., 2021). Character education at the primary school level must equip kids with an environmentally conscientious mindset to prevent environmental harm. Engaging kids with environmental issues and challenges in their immediate environment, this will help them develop social sensitivity. Waste, floods, air pollution, and global warming are global challenges that can serve as a basis for evaluating pupils' ecological literacy (Herdiantyka, 2019). Both non-living items and living things, such as plants and animals, must be protected in the immediate surroundings. According to Ihsani (2025), If the environment is preserved, prosperity will result, but destruction is not unthinkable if it is not, either.

Dust, trash, and smells are examples of pollutants that are absent from a clean and healthy environment. A clean and healthy environment must be free of viruses, dangerous bacteria, and disease vectors, as these microorganisms can spread illness. Potentially dangerous contaminants must be absent from a safe and healthy environment (Widiyasari et al., 2021). Ecology comes from the Greek term oikos, which means house. In a broad sense, this term refers to the entire universe, including Earth, all habitats or homes, and "eco" is usually used for the word "environment". Etymologically, science is the knowledge of caring for and preserving the universe where living beings exist (Rusmawan, 2017). This ecological literacy must be instilled from elementary school onward. This integration will certainly be related to the consistency of the curriculum in formal education (schools) (Kusumaningrum, 2018). When elementary school students begin to enter the formal operational stage, they are in the final stage of childhood. Individuals at this level think abstractly and logically through real-world experiences. They create idealistic conditions from various events as a result of their ability to think abstractly (Rusmawan, 2017).

Observations by researchers indicated that many students still exhibit low environmental awareness. This is reflected in behaviours such as littering, leaving classroom floors unclean, leaving waste under desks, and the frequent use of plastic-packaged snacks and plastic straws in daily activities. Ecological literacy can be developed not only in schools but also at home and in the community. Because it is directly related to daily life, ecological literacy becomes a very important subject, making it easier for students to remember and find it more meaningful when they study it because they have direct access to the real world (Ginting et al., 2018). Students are required to contribute to raising awareness and sensitivity toward environmental issues through the educational process. Science learning is one of the subjects that align with students' ecological literacy skills, compared with social studies and environmental education. As the name suggests, science is the study of natural phenomena, specifically a branch of knowledge that deals with nature and the surrounding environment. Learning that involves environmental knowledge will foster awareness, promote environmentally friendly behavior, develop environmental ethics, and promote responsible action to address environmental issues. Students can explore stoichiometry principles in a hands-on, interactive way through active science learning activities, which improves

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their conceptual comprehension (Wannomai et al., 2024). If teachers present material using methods that are appropriate for students' cognitive abilities, students will understand it more easily. For example, when teaching science, teachers should not only use the lecture method; they should also use experiments (practice) or provide direct examples (modeling) related to the objects being studied (Bujuri, 2018).

Ecological Literacy (EL) refers to the understanding and application of ecological principles to address environmental issues. It involves recognizing the interdependence among living organisms and ecosystems, as well as the impacts of human actions on the environment (Pitman & Daniels, 2020; Pouresmaieli et al., 2024). Ecological literacy is knowledge and understanding of nature and how ecological systems function. Ecological literacy assesses one's understanding of ecological processes, concern for the environment, and activities to reduce negative consequences for environmental issues (Prastiwi et al., 2020). This ecological literacy is also important to improve in learning by using learning models. Ecological literacy is a multifaceted concept that involves knowledge, skills, attitudes, and behaviors essential for sustainable living. Effective education strategies, including experiential learning, interdisciplinary approaches, and early integration, are vital for developing ecologically literate individuals capable of addressing environmental challenges (Naila et al., 2025; Sarbassova et al., 2021; Ubaydullaeva et al., 2026).

Ecological literacy is closely connected to an individual's ecological culture and environmental awareness (Nadtochiy & Timoshkina, 2024). To improve ecological literacy requires learning that is constructive and allows for direct interaction between students and the environment. The learning activities referred to are not only those carried out by the teacher but also all activities performed by both the teacher and students that directly impact the learning process (Bahij & Santi, 2017). Learning models will enhance skills and competencies appropriate to abilities if used correctly. Learning models are classroom learning activities that encourage students to learn actively while also fostering a fun learning environment in the classroom (Panggabean et al., 2021). Factors influencing ecological literacy include: the PLH subject being removed from the 2013 curriculum, limited facilities to support the implementation of PLH learning in elementary schools, including green spaces in schools, especially in urban schools, a lack of learning tools and media, limited PLH learning resources such as teachers and learning materials in the form of textbooks on ecopedagogy, and a lack of teaching models, strategies or methods in the classroom (Hendrawan et al., 2020).

The choice of learning models is determined by the source material, its presentation, and its reception. The case method model aims to understand the phenomenon of what is experienced by research subjects holistically and by means of descriptions in the form of words and language in a special natural context, and by utilizing various scientific methods (Agustan, 2023). Learning models are used for specific subject matter. Because if applied to existing material, not all available learning strategies are suitable for implementation. Among the many learning models, the case method (problem-based learning) and project-based learning are examples that align with the characteristics of the 2013 curriculum in the 21st-century education era. The case method learning is a method that presents students with real-life problems where learning stimulation is developed. Thus, students can think critically, analyze problems, and solve them using various sources (Salsabilla et al., 2014). Meanwhile, Project-Based Learning is an innovative teaching model that promotes contextual learning through complex activities involving a project. Learning focuses on the basic ideas and principles of a subject, engages students in problem-solving and other relevant activities, and provides them with opportunities to think critically and creatively, conduct skilled research, and ultimately produce real-world products and address real-world issues (Lesmana & Jaedun, 2015). There has been a lot of talk about active learning methods, but there is still some doubt about which one is better for ecological literacy: the case method, which focuses on problem analysis, or project-based learning, which focuses on real-world solutions.

Learning models are determined not only by students' knowledge but also by teachers' understanding. Learning models are outlined in lesson plans, which are then derived from

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teaching methodologies; therefore, teachers play an important role in selecting the strategies to be used in the learning process (Panggabean et al., 2021). Learning models are based on five learning aspects essential to the learning process (Conti & McNeil, 2024). Learners who approach tasks or issues differently based on their unique biological and cognitive features originate, implement, and monitor strategies (Alexander et al., 2018). Hopefully, students can use their creativity to solve problems. This learning models, involving real-life situations, allow students to connect theory and practice, as well as problem-solving skills. Based on the above explanation, the researcher conducted a study to examine "Case Method and Project-Based Learning Models to Enhance Ecological Literacy."

METHODS

This research uses a quantitative method for finding, presenting, and analyzing data in numerical form (numbers) or through experimental results. In the research conducted, this study applied a quasi-experimental design because the author could not control external factors influencing the research variables, and the quantitative approach was used because this research aims to test the hypothesis and determine the effect of the independent variable on the dependent variable through statistical analysis (Angla et al., 2026). The quasi-experimental method was chosen because, in its implementation, the researcher could not fully randomize the subjects, but still used a control group for comparison to assess the effectiveness of the treatment given (Rijjal et al., 2024). The research design employs a pretest-post-test non-equivalent group design factorial 2×2.

Population and Samples

Population is the general object or topic, with specific qualities and characteristics, that is investigated by the researcher and from which conclusions are drawn. The population in this study consists of all fourth-grade students at Public School, which comprises three classes totalling 90 students. The sample consisted of 60 students from Classes IV-A and IV-B, selected via purposive stratified sampling based on pre-test ecological literacy scores (30 high-literacy students and 30 low-literacy students). These were randomly assigned to four groups (n=15 each): Case Method (high/low literacy) and Project-Based Learning (high/low literacy).

Instruments

The data collection tool used by the researcher was given to students to measure their learning outcomes in accordance with the material that had been provided. In this study, the author aims to gather information about the influence of case method and project-based learning strategies on ecological literacy. The researcher employed a test instrument in this investigation. The test was used as a tool to gauge how well the provided subject was being learned. The test instrument contains questions related to the ecological literacy aspect of knowledge. The tests used were a pre-test and a post-test, administered before and after learning in each experimental class. The test is multiple-choice, with 25 questions and 4 answer options. The instrument used has gone through validation process using SPSS 22. The instrument grid is shown in Table 1.

Data Collection Techniques

The treatment design in this study integrated the learning models with students' initial ecological literacy levels (high and low), resulting in four distinct class groups. The grouping is presented in Table 2. Tests serve as assessment tools, that is, questions given to students to elicit answers in oral, written, or action-based forms. Data were collected as multiple-choice objective test questions. In this study, a test was administered consisting of a series of questions on the material presented to assess student learning outcomes. The questions were in multiple-choice format,

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administered at the beginning of the activity as a pre-test and at the end as a post-test. The pre-test results were used to group students according to their level, namely, high ecological literacy or low ecological literacy. Then, the first experimental class received treatment using the case-method learning strategy, while the second experimental class received treatment using the project-based learning approach. These two datasets were compared to obtain a final value in order to determine the effect of the learning strategy being studied. Observations were conducted by examining the students' learning processes. The findings were subsequently used to analyze instructional practices and obtain a comprehensive understanding of the research context. Documentation is a data-collection procedure used to make data more concrete and to support the research with evidence.

Table 1
Research grid and instruments.

Variable	Competence	Indicator	Number Question
Ecology literacy	Knowledge	Recognizing environmental concerns and challenges from the standpoint of sustainability and ecological balance.	1, 2, 3, 4, 5, 6, 7, 8
		Understanding the basic principles of ecology	9,10,11,12, 13, 14, 15
		Critical thinking, innovative problem-solving, and applying knowledge in new contexts.	16, 17, 18, 19, 20
		Considering the long-term consequences that will be obtained.	21, 22,23, 24, 25

Table 2
Sample class distributions.

Category	Case Method (A1)	Project-based learning (A2)	Total
High literacy ecology (B_1)	A1B1 Learning model case method with ecological high literacy 15 students	A2B1 Learning model Project-Based Learning with High Ecological Literacy 15 Students	30 students
Low literacy ecology (B2)	Learning model: Case Method with Low Ecological Literacy, 15 Students	Learning Strategy: Project-Based Learning with Low Ecological Literacy in 15 Students	30 students

Analysis Prerequisite Test

The normality test simply assesses the normality of the data under study. In this study, data normality was calculated using the Shapiro-Wilk test with the assistance of SPSS version 20.0 for Windows. The normality guidelines are as follows: if $\alpha > 0.05$, the test is considered normally distributed; if $\alpha < 0.05$, the test is considered not normally distributed. The homogeneity test is useful for determining the similarity of samples, specifically whether the variations of the samples taken from the population are uniform or not. Homogeneity rule: if > 0.05, the test is considered

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homogeneous; if 0.05, the test is said to be non-homogeneous. To test for homogeneity, we use the Levene test formula. Homogeneity testing is done by dividing the largest variance by the lowest variance found.

Two-way ANOVA is used to test the relationship between two independent factors, namely the case method learning strategy and the project-based learning strategy, with the dependent variable of ecological literacy, which is divided into two categories: high ecological literacy and low ecological literacy. It is hoped that the two-way analysis of variance will reveal differences in the learning strategies of the case method and project-based learning on ecological literacy. In conclusion, the significance value in the between-subjects effects table from the analysis of variance is interpreted to determine whether ho is accepted or rejected. The criterion for drawing a conclusion is that H0 is rejected and Hα is accepted if the likelihood of error p is less than 0.05.

RESULTS AND DISCUSSION

The learning strategies used in experimental class I and experimental class II were implemented in 3 sessions: pre-test, treatment administration, and post-test. The pre-test results were used to group students according to their level, namely, high ecological literacy or low ecological literacy. Then, treatment was administered in experimental class I using the case-based learning model and in experimental class II using the project-based learning model. Based on his calculations for the entire sample of 60 students, the results shown in Table 3 were obtained as follows:

Table 3
Average posttest score between four groups.

Group	Average Score
A1B1	71,33
A2B1	83,33
A1B2	66,00
A2B2	68,33

After being grouped, the students' post-test score data were processed in SPSS. The average score for students with high ecological literacy who were taught using the case-based learning strategy is 71.33. The average score for students with low ecological literacy taught using the case method learning strategy is 66.00. This means that students with high ecological literacy taught using the case method learning strategy achieved an average learning outcome 5.33 points higher than students with low ecological literacy taught using the case method learning strategy. Furthermore, the average score for students with high ecological literacy taught using the project-based learning strategy is 83.33. The average score for students with low ecological literacy taught using the project-based learning strategy is 68.33. This means that students with high ecological literacy taught using the project-based learning strategy had an average learning outcome 15 points higher than students with low ecological literacy taught using the project-based learning strategy. In conclusion, students taught using the project-based learning strategy are superior to students taught using the case method.

The results of the normality test for each analysis group were conducted at a significance level of 5% or 0.05. A significance value of p > 0.05 indicates that the data is normally distributed, according to the results of the data normalcy tes. The calculation results can be seen in the appendix. Levene's Test was used in this study to determine homogeneity. The homogeneity test used aims to assess the homogeneity of variances in each of the compared classes, both in the case method experimental class and the project-based learning experimental class. Following the acquisition of homogeneous, normally distributed pre-test and post-test data, the hypothesis was

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examined using two-way analysis of variance (two-way ANOVA). Based on the results of the two-way ANOVA test, the following conclusions can be drawn: a) Hypothesis of the effect of case method and project-based learning strategies on ecological literacy. Two-tailed hypothesis (A1 and A2).

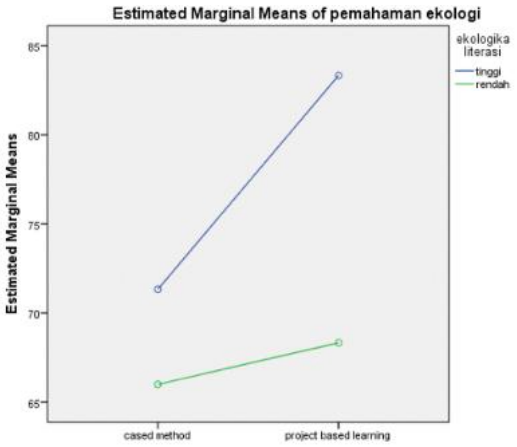
Table 4
Two-way ANOVA result.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
learning strategies* ecological literacy	350.147	1	350.147	9.127	.004

h_o : $\alpha \times \beta = 0$
h_α : $\alpha \times \beta \neq 0$

From the analysis in Table 4, we obtained Fo (AB) = 9.127; df (1, 56); p-value = 0.004 < 0.05, therefore Ho is rejected. This indicates that there is an interaction effect between learning strategies (project-based learning and project-based learning) and ecological literacy ability (high and low) on ecological literacy. The effect size of the interaction between learning strategies and ecological literacy ability (η2) = 0.140. In conclusion, the influence of learning strategies on ecological literacy depends on students' high and low levels of ecological literacy. Visually, the interaction between learning strategies and literacy ecology is presented in the following figure (Figure 1).

Figure 1
Visual of learning strategies in relation to literacy ecology.



Learning strategies using the case method and project-based learning on the ecological literacy abilities of high-category students. H0: μA1B1 ≤ μA2B1 hα: μA1B1 > μA2B2. From the analysis in Table 4.12 (Assume equal variances), the following results were obtained: to (A1B1 x A2B1) = -5.304; df = 56; p-value = 0.000 < 0.05, therefore H0 is rejected. Thus, the average ecological literacy ability of students taught using the case method learning strategy is lower compared to the project-based learning strategy for students with high ecological literacy abilities.

The effect of the case method and project-based learning strategies on the ecological literacy abilities of low-category students. H0: μA1B2 ≤ μA2B2 hα: μA1B2 > μA2B2. From the

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analysis in Table 4.12 (Assume equal variances), the following results were obtained: to (A1B2 x A2B2) = -1.031; df = 56; p-value = 0.307 > 0.05, therefore H0 is accepted. Thus, the average ecological literacy ability of students taught using the case method learning strategy is lower than that of students with low ecological literacy ability.

This study was conducted in two fourth-grade classes assigned as Experimental Class I and Experimental Class II, each implementing different instructional strategies: the case method and project-based learning (PjBL). The case method encourages students to engage in critical thinking to address real-world problems, with learning outcomes typically presented in written or oral forms. In contrast, PjBL engages students in developing projects based on the subject matter and its connection to real-life contexts, producing outputs such as posters, models, prototypes, or performances. Students in each class were further categorized into high and low ecological literacy groups based on their pre-test scores, using the highest and lowest score distributions. This quasi-experimental study compared the effectiveness of the case method and PjBL across these ecological literacy levels (Creswell & Creswell, 2018). Each experimental class consisted of 30 students, with 15 in the high ecological literacy group and 15 in the low ecological literacy group. In one class, although the initial number of students exceeded 30, only 30 were included in the analysis due to sampling criteria based on pre-test results.

According to data analysis, students in classes IV A and IV B who were taught using the case method learning strategy and those who were taught using the project-based learning strategy had different levels of influence on ecological literacy. The project-based learning strategy requires students to improve their ability to complete the given project worksheets, which will help them generate ideas, opinions, and concepts while engaging in activities such as designing, problem-solving, and researching what they are doing, thus further enhancing their abilities. The case method learning strategy is essentially a strategy that allows teachers and students to build activities. The case method learning strategy encourages students to think critically, solve problems, learn individually, and participate in groups. However, the application of the case method learning strategy yields less satisfactory results compared to the project-based learning model. This is because the case method of learning requires a considerable amount of preparation time and demands critical thinking from students. If students experience failure and lack confidence in problem-solving, and their interest is still low, they will be reluctant to try it.

Based on the research findings, students who were taught using the case method learning approach and those who were taught using the project-based learning strategy had different average ecological literacy levels. This indicates that the average ecological literacy of students taught using the project-based learning strategy is higher than that of students taught using the case method learning strategy. It can be concluded that the project-based learning strategy is more successful in improving students' ecological literacy compared to the case method learning strategy. PjBL outperformed Case Method on ecological literacy (higher post-test means), as PjBL fosters idea generation, problem-solving, and real-world products (e.g., posters/models), aligning with constructivist principles (Krajcik & Shin, 2014).

The findings of the data analysis indicate that learning techniques interact with one another by (project-based learning and project-based learning) and ecological literacy ability (high and low) on ecological literacy. This means there is an interaction between the influence of learning strategies on ecological literacy. Therefore, the influence of learning strategies on ecological literacy depends on students' high and low ecological literacy abilities. The findings on the form of interaction indicate that the main research factors, consisting of two factors, have a significant interaction. First, students with high ecological literacy skills taught using project-based learning strategies performed better than students with high ecological literacy skills taught using the case method learning strategy. Second, students with High ecological literacy skills taught using project-based learning strategies are superior to students with low ecological literacy skills taught using the case method learning strategy. Third, students with high ecological literacy skills taught using

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project-based learning strategies perform better than students with low ecological literacy skills taught using project-based learning strategies. Significant interaction occurred between models and initial literacy levels ($p<0.05$ via two-way ANOVA). PjBL excelled for both groups, but especially high-literacy students, due to authentic projects enhancing prior knowledge application (Bell, 2010).

The data analysis results demonstrated that the impact of project-based learning methodologies and the case method differed on the ecological literacy abilities of high-level students in classes IV A and IV B. The average ecological literacy ability of students taught using the case method learning strategy was lower compared to the project-based learning strategy for students with high ecological literacy abilities. The research conclusion is that the project-based learning strategy is more effective in improving students' ecological literacy abilities compared to the case method learning strategy for students with high ecological literacy abilities. For high-literacy students, PjBL > Case Method (better conceptual integration). For low-literacy, PjBL still superior, building foundational skills via hands-on tasks. These align with meta-analyses showing PjBL's edge in motivation and literacy outcomes (Chen & Yang, 2019).

The findings of the data analysis indicate that the case method and project-based learning strategies have different effects on low-category students' ecological literacy skills in grades IV A and IV B. For students with inadequate ecological literacy, the case-based learning approach yields lower average ecological literacy than the project-based learning strategy. The research conclusion is that the project-based learning strategy is more effective in improving students' ecological literacy abilities compared to the case method learning strategy for students with low ecological literacy abilities.

CONCLUSION

Students taught using the case method learning strategy and those taught using the project-based learning strategy have different effects on ecological literacy. Compared to the case technique, the project-based learning approach is superior. Learning methodologies (case method and project-based learning) and ecological literacy ability (high and low) significantly interact. The case method and project-based learning strategies in the sample group with high ecological literacy ability show a substantial difference in ecological literacy ability compared to the other sample groups. Using the case method and project-based learning strategies in the sample group with low ecological literacy ability shows a significant difference in ecological literacy ability compared to the other sample groups. To get the most out of learning, teachers should use project-based learning methods that fit their students' ecological literacy levels. Schools must also help develop a modified curriculum and train teachers to design environmental projects that will engage kids of all reading levels.

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