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Project Based Marine Biodiversity Education to Improve Ocean Literacy and Conservation Attitudes Among Secondary Students

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Abstract

Deteriorating marine ecosystems and biodiversity deterioration have become a matter of global concern, and some educational intervention is needed. The study will examine how marine biodiversity education project-based instruction affects ocean literacy and conservation rates among high school students. Ocean literacy, which refers to the knowledge of the basic fundamentals and concepts regarding the role of the ocean on us and vice versa, is also an important issue in developing environmental stewardship in future generations. The study takes a project-based approach to learning so as to inform the students about the marine biodiversity with the view of improving their knowledge about the marine environment and imparting a positive attitude towards conservation. The change in ocean literacy among the students and their perceptions about marine conservation were measured by pre- and post-education tests. The findings show that there is an excellent enhancement of the ocean literacy and conservation attitudes among the participants. The paper will discuss the effectiveness of project-based education in promoting these results and compare the findings to the existing literature. It also addresses the educational policy implications and

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the prospects of further implementation in the curriculum of secondary schools. The study reveals that there is a necessity for new teaching approaches in order to enhance environmental awareness, especially with regard to maintaining marine biodiversity. Future research recommendations and the emergence of similar programs are outlined, with the importance of how education can contribute to the conservation of the sea.

Keywords:

Marine biodiversity, ocean literacy, conservation attitudes, project-based education, secondary education, environmental stewardship, marine conservation.

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Introduction

Ocean literacy is the concept of the impact of the ocean on human beings and vice versa. It includes information on marine ecosystems, ocean processes, as well as the relationship between marine health and human well-being (Asikin et al., 2025; Mioni, 2022). Conservation attitudes, in contrast, are the perceptions, beliefs, and actions of individuals with regard to the protection and preservation of the marine resources. These are attitudes that are developed through education, awareness, and participation in environmental matters, which affect the behavior towards sustainable practices and conservation efforts (Kevrekidis et al., 2024).

The significance of marine biodiversity education to secondary students is essential in promoting ocean literacy and developing conservation dispositions (Velliangiri, 2025; Koulouri et al., 2022; Mutanda & Nhamo, 2025). Being the future custodians of the planet, young people must create an informed perception of the crucial importance of oceans as regulators of climate, biodiversity, and the sustenance of human life. The use of project-based learning, promoting active learning with real-world challenges, has been found to be effective in enhancing the level of knowledge acquisition and attitudes. The given approach assists the students in understanding the complexity of marine ecosystems more deeply, working on the aquatic biodiversity, and underlining the importance of conservation activities.

The primary goal of the paper is to explore how the project-based marine biodiversity education has the potential to boost ocean literacy and attitudes toward conservation among secondary-level students (Wang et al., 2025; Tsai et al., 2023). The research aims at assessing the impact of this kind of educational intervention on the level of awareness that the students possess of the marine ecosystems and whether they are ready to adopt conservation-based practices (González et al., 2025). By comparing the pre- and post-education assessment, the paper aims to give a meaningful contribution to the objective of the potential of this educational model as an addition to the overall idea of marine protection (Torralba-Burrial & Dopico, 2023). The research of this paper may guide upcoming educational policies and practices that are used to improve environmental stewardship (Freitas et al., 2024).

Key Contributions

- Provides evidence to that effect in the form of In-depth research and studies, which show that project-based marine biodiversity education is an effective way to improve ocean literacy and conservation values in secondary school students.
- Integrates quantitative (pre/post surveys) and qualitative (student reflections, group discussions) approaches to evaluate the effect of the education program.

- Offers suggestions that may be conducted on future research regarding the long-term impact, digital technology in marine education, and community involvement in marine conservation education.

The paper starts with an Introduction that describes the significance of ocean literacy and conservation attitudes, which support the role of project-based marine biodiversity education (Poornimadarshini, 2024). The Literature Review provides the existing studies on the effectiveness of such education and establishes the gaps in ocean literacy. The Methodology explains the pre- and post-tests of the survey, student reflection, and teacher observation of the study in order to collect the quantitative and qualitative information. Results indicate that on a proportion of ocean literacy and conservation attitudes, improvement in pre- and post-interventions is significant. Discussion is the interpretation of these findings with the limitations and proposed direction of future research. Lastly, the conclusion is the summary of the findings, recommendations to consider project-based marine biodiversity education as an integral part of the training, and suggestions to carry out further research on the topic.

Literature Review

As it has been revealed, environmental education is one of the most significant factors influencing the knowledge of the students about the ecological problems, including marine biodiversity (Salazar-Sepúlveda et al., 2023). The studies also indicate that there is a positive influence of the marine education programs, which are targeted, towards increasing the knowledge of students on the aquatic ecosystem and promoting environmentally responsible behaviors. As an example, marine biodiversity and ocean life programs, including overfishing and pollution, have been discovered to enhance the knowledge of students regarding the significance of the ocean. Such an understanding, in its turn, has been associated with more positive views on conservation efforts. Research also indicates that hands-on activities in the form of field trips, a laboratory, or project learning are more likely to help students remember the material and use it in real-life situations.

Although ocean literacy has been an essential issue in the field of environmental education, significant differences do exist in ocean literacy levels among various populations (Mallick et al., 2023; Pazoto et al., 2023). Research has shown that the knowledge of marine science by students is usually small, and in areas where the marine environment is not available to the students (Gómez et al., 2025). Marine science is not fully incorporated in most learning institutions, and this is the cause of low awareness of marine biodiversity issues. Additionally, conservation attitudes are disparate depending on geographical setting, socio-economic issues, and previous exposure to environmental education (Alves et al., 2025). Overall, it is evident that the more the population is exposed to marine ecosystems, the more they have a positive attitude towards protecting them and the more knowledge they have about issues related to the oceans. This demonstrates the necessity of the availability and thorough marine biodiversity educational programs that target every student, wherever they are located (Pazoto et al., 2024).

Project-based learning (PBL) has become one of the effective techniques for enhancing ocean literacy and developing conservation attitudes (Ceccaroni et al., 2023; Kao et al., 2025). PBL involves real-life problems for students and challenges them to cooperate, solve problems, and be active in their learning. This method has been found to improve critical thinking and retention of students. Also, hands-on learning activities, i.e., beach cleanups, coral reef monitoring, or marine biodiversity surveys, allow students to be directly exposed to the aquatic environment and marine issues. The studies indicate that such learning experiences are very effective in enhancing the development of a strong environmental responsibility. Besides, one of the practical solutions to the obstacles of geographic constraints in certain learning establishments has been the integration of digital resources, including interactive marine ecosystems, simulations, and virtual field trips. These are various instructional techniques that aid in making the learning process more real and encourage the students to develop ocean literacy and positive conservation behaviors (Costa & Faria, 2025; Freitas et al., 2025).

Literature shows that Project-based learning (PBL) contributes to the development of ocean literacy and conservation attitudes dramatically, because students are involved in real-life activities. Although marine education is positive with regard to knowledge and conservation practices, literacy gaps still exist, particularly where marine education is scarce. Such aspects as previous knowledge, socio-economic status, and access to marine environments influence the attitudes of students, which explains the need for the application of inclusive and contextually-appropriate instruction to improve ocean literacy and develop conservation in heterogeneous groups.

Methodology

The study employs a project-based learning (PBL) method of marine biodiversity education wherein the student is subjected to practical, real-world projects that target marine conservation issues. The strategy will promote learning in the form of active participation, critical thinking, and collaboration between the students as they read about aquatic ecosystems, gather data, and come up with solutions to environmental challenges. The PBL model guarantees that the students not only learn but also obtain the pragmatic knowledge of environmental science, marine biodiversity, and conservation measures.

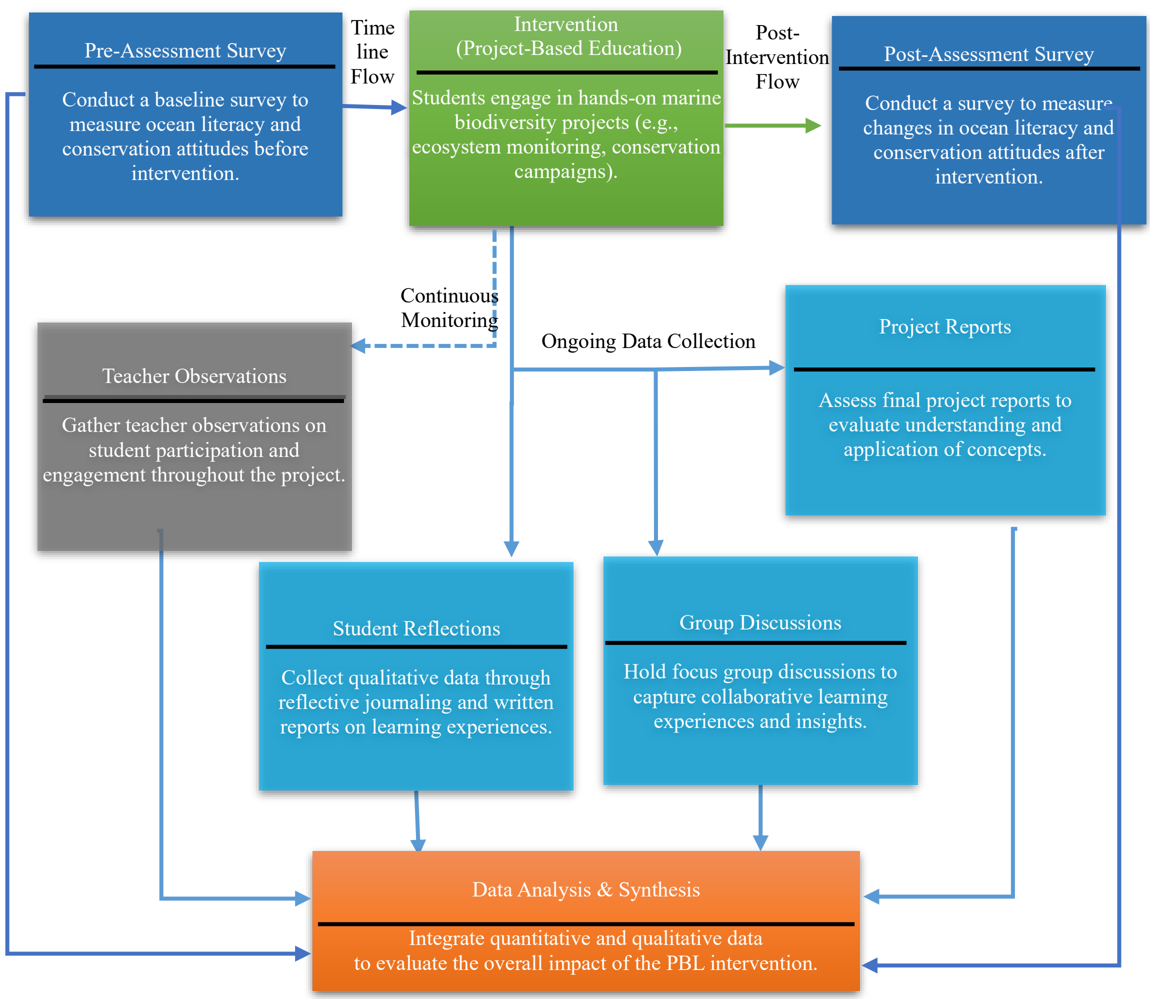

Figure 1. Project-Based learning approach flowchart

Figure 1 presents the data collection process of determining the influence of project-based marine biodiversity education. It will start with a Pre-Assessment Survey in order to assess ocean literacy and conservation attitudes prior to the intervention. It is then followed by the Intervention phase, after which practical projects are carried out by the students who are involved in working on marine biodiversity. The Post-Assessment Survey is applied to determine the difference in knowledge and attitudes after the intervention. All through, the qualitative data is constantly gathered in the form of Teacher Observations, Student Reflections, Group Discussions, and Project Reports, giving data on the student engagement and learning. Finally, another stage is the Data Analysis and Synthesis, which involves quantitative and qualitative data analysis to find out the overall impact of the education program. The mixed-method approach, pre- and post-assessment surveys, continuous monitoring, and qualitative feedback are the aspects of the diagram that measure the success of the project-based learning intervention.

The proposed study uses a pre- and post-assessment design, which is aimed at measuring the effects of the project-based marine biodiversity education on the ocean literacy and the conservation attitudes of the students. It is a mixed-method approach where quantitative and qualitative data are involved. The quantitative data will be collected using questionnaires that measure the ocean literacy and conservation attitudes of the students, before and after the intervention of the project-based learning. The questions in the surveys will be Likert scales and multiple-choice questions. Also, student reflections, project reports, and group discussions will be used to gather qualitative data to understand their learning experiences and how they have changed in their conservation behavior.

The target market involves secondary school students aged 14-18 who are in the coastal and inland areas. The schools with existing environmental education programs will be selected by a purposive sampling method, thereby having a well-balanced sample of students with varying degrees of prior knowledge on the subject of marine biodiversity. The sample will be 200, with an equal number of 100 students in the coastal schools and 100 students in the inland schools. With the assistance of this sample size, it is possible to compare the effects of project-based education in different geographical settings. There will be certain project groups of students that will be working on specific topics of marine biodiversity to encourage collaboration and interaction.

Table 1. Data collection process

Data Collection Method	**Description**	**Tools/Techniques Used**
Pre-Assessment Survey	To assess baseline ocean literacy and conservation attitudes before the intervention.	Online survey tool (Google Forms, SurveyMonkey)
Post-Assessment Survey	To evaluate changes in ocean literacy and conservation attitudes after the intervention.	Online survey tool (Google Forms, SurveyMonkey)
Student Reflections	To capture qualitative data on students’ learning experiences and changes in attitudes.	Reflective journaling, written reports
Group Discussions	To explore the collaborative aspects of the project and understand group dynamics and learning.	Focus group discussions, audio recordings
Project Reports	To assess the quality of the students' research and their ability to apply learned concepts.	Project-based reports, peer reviews
Teacher Observations	To provide insights into student engagement and participation throughout the project.	Observation checklist, field notes

Table 1 gives a tabular description of the various data collection techniques applied to measure both quantitative and qualitative research. It contains the instruments and methods of the data collection, as it makes sure that every part of the research is recorded in the correct and complete way.

Results

The outcomes of the research are that both the ocean literacy and the conservation attitudes of students who attended the project-based marine biodiversity education at secondary schools improved significantly. The post- and pre-assessment surveys showed that the students exhibited a significant improvement in their knowledge of the aquatic ecosystems, biodiversity, and the significance of marine conservation. The average score of students given ocean literacy questions rose by 30 points, and their perception towards marine conservation became more positive, as indicated by a 25 percent increase in the level of their agreement with statements concerning the protection of aquatic resources.

Table 2. Comparison of pre- and post-education assessments

Survey Topic	Pre-Education Average Score (%)	Post-Education Average Score (%)	Change (%)
Ocean Literacy	55%	85%	+30%
Conservation Attitudes	60%	85%	+25%
Engagement in Conservation Actions	50%	80%	+30%

Table 2 indicates the percentage change in the main areas following the marine biodiversity education through projects. It shows that the level of ocean literacy, conservation attitudes, and action towards conservation increased significantly as a result of the intervention.

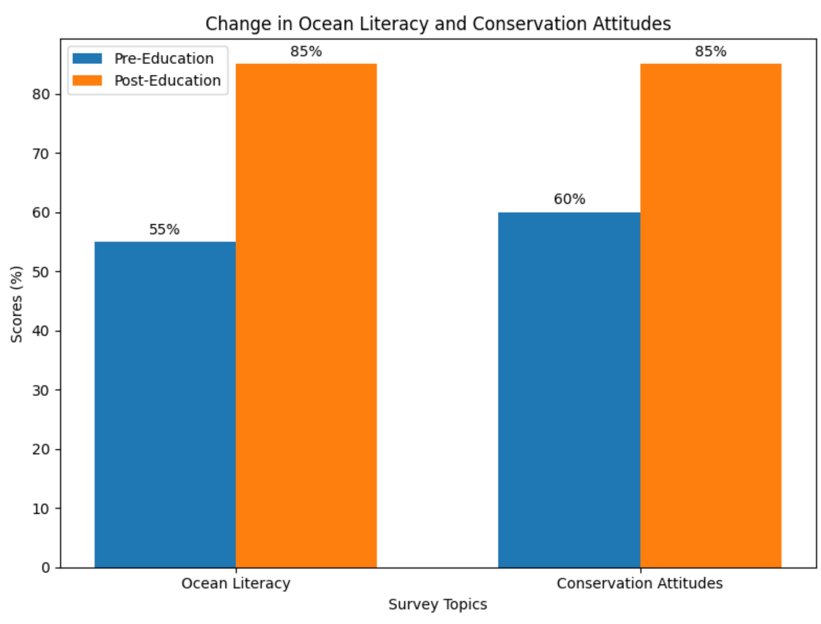

Figure 2. Comparison of pre- and post-education scores

Figure 2 presents the comparison of the Pre-Education and post-education scores of Ocean Literacy and Conservation Attitudes. The survey topics (Ocean Literacy, Conservation Attitudes) would be used as the X-axis, and the percentage scores would be used as the Y-axis. The scores of each topic would be represented in two bars, with one representing the score at the pre-education stage and the other at the post-education stage. The graph would be an accurate way of showing the improvement of both areas.

Implications of the Results for Future Marine Biodiversity Education Initiatives

The results indicate that project-based education is a powerful means of improving ocean literacy and gaining conservation attitudes. A good shift in the knowledge and attitudes of the students is why hands-on, experiential learning in environmental education is essential. Incorporating such project-based strategies into future programs might be beneficial, especially those where the students have the opportunity to work on real-life problems concerning the environmental issue of marine conservation. These findings also remove the significance of the inclusion of ocean literacy within the wider educational programs and show its applicability to social and ecological health. Moreover, it is proposed in the study that ongoing observation and reflection of the learning journey are necessary to strengthen the learning process and encourage behavior change over the long term.

Discussion

The results of this study correspond to the existing literature stating the effectiveness of project-based learning (PBL) to improve environmental education. According to the earlier research, project-based methods involving real-world practice can be an effective way to enhance the level of knowledge and attitude towards ecological problems among students. The substantial growth of ocean literacy and positive attitudes towards conservation in students in this study is in line with other studies that demonstrate that PBL enhances greater engagement, retention, and motivation to action in environmental problems. Moreover, the improved conservation attitudes are also an indicator that experiential education can be used to motivate students to become responsible towards marine conservation.

Although the outcomes are encouraging, they have a number of limitations that must be noted. The sample size and choice of schools may be considered as one of the possible limitations. Though the number of students used in the study (200 total students) was large, the study sample only consisted of coastal and inland schools that already had existing environmental education programs. This sample might not be reflective of the larger population of secondary students, especially within regions with limited marine biodiversity exposure. The research was also based on self-reported information from student surveys and reflections, which can be a source of bias or errors. Future research would be enriched by a wider sample and the addition of objective evaluation (standard tests) in order to supplement qualitative data.

This research could be expanded in future studies to have a long-term effect of project-based marine biodiversity education. A question about time would be beneficial in determining whether the changes in ocean literacy and conservation attitudes are long-lasting or after some time; students revert to their pre-education levels regarding their behaviors and attitudes. Moreover, the study can be extended with the aim of examining the efficiency of the mentioned form of education in other age groups, geographical areas, and educational settings. Another way that researchers could explore the use of digital tools to better marine biodiversity education is the evolution of how the learning experience can be improved through the integration of digital tools, like virtual field trips or online simulations. Finally, the discussion of the role of community engagement and collaboration with the local conservation organizations might give some ideas on the role of external factors in the success of marine education programs.

Conclusion

This research proves that marine biodiversity education through projects is a solid tool to improve ocean literacy and influence positive conservation values among students of secondary schools. The post and pre-assessment outcomes showed a significant improvement in the knowledge of students about marine ecosystems and biodiversity, and a change in the pro-conservation attitude. It is on these findings that the schools consider incorporating hands-on, project-based learning activities in the curriculum to make the students experience the real-world problems of marine conservation. Interdisciplinary work and participation in the local conservation organizations can also be used to add more to the learning process. Lastly, the future of marine life also greatly relies on the improvement of ocean literacy and the creation of conservation-related attitudes, as they are the educational techniques that can be employed to create a generation of conscientious environmental protectors. The further evolution of such work and its long-term outcomes will be significant in developing a more aware and active global population in terms of the environment. Future research can be directed at long-term maintenance of ocean literacy and ocean conservation attitudes, the effectiveness of virtual or digital tools in marine education, and how community-based programs can be used to complement educational programs in promoting marine conservation. Moreover, the studies can also examine the effectiveness of project-based marine biodiversity education by investigating the effect of different age categories or regions.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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