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Effectiveness of Instructional Approaches in Promoting Ocean Literacy in Formal Education: A Systematic Literature Review

Lianto[1*], Marosa Robi'atul Adawiyah[1]

[1]Biology Education, University of Mataram, Mataram, Indonesia.

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Abstract: Ocean literacy is increasingly recognized as a key component of education for sustainable development, particularly in addressing global marine challenges. However, its integration into formal education remains limited, and the effectiveness of instructional approaches is not yet well understood. This study aims to examine instructional approaches used to promote ocean literacy in formal education, analyze their pedagogical characteristics, evaluate their effectiveness based on learning outcomes, and identify research gaps. A systematic literature review (SLR) was conducted using the Scopus database, covering publications from 2016 to 2026. The study selection followed PRISMA guidelines, resulting in four empirical studies that met the inclusion criteria. The findings indicate that inquiry-based learning (IBL) is the most consistently implemented and effective approach, particularly when combined with experiential and context-based activities such as fieldwork and hands-on practices. These approaches significantly improve students' knowledge, attitudes, and pro-environmental behavior. In contrast, project-based learning (PjBL) demonstrates moderate and inconsistent effectiveness. Although problem-based learning (PBL) and case-based learning (CBL) are frequently recommended in the literature, no empirical evidence of their implementation was identified. These findings highlight a significant concept–practice gap between theoretically proposed approaches and their practical application. This study emphasizes the importance of experiential inquiry and recommends further empirical research on underutilized approaches such as PBL and CBL.

Keywords: Ocean literacy, Inquiry-Based Learning, Project-Based Learning, Systematic Literature Review.

Introduction

Ocean literacy has become an essential educational framework aimed at fostering informed interactions between humans and marine environments, particularly in light of global challenges such as climate change and biodiversity loss. The United Nations Decade of Ocean Science for Sustainable Development (2021–2030) emphasizes ocean literacy as a pivotal element in bridging scientific understanding with societal action, thereby enabling individuals to make informed decisions that promote sustainable ocean governance (Glithero, Bridge, Paul, & McRuer, 2025; Borja, Santoro, Scowcroft, Fletcher, & Strosser, 2020). This framework not only enhances public awareness of the importance of marine ecosystems but also encourages responsible behaviors that mitigate human impacts on these environments (Borja et al., 2020; Worm et al., 2021). Furthermore, ocean literacy is increasingly recognized as a societal outcome that requires inclusive engagement across diverse cultural contexts, thereby transforming collective awareness and relationships with the ocean (McKinley, 2024). By integrating various perspectives, including indigenous and community insights, ocean literacy can effectively support ongoing efforts to

Email: lianto@staff.unram.ac.id

restore marine biodiversity and promote sustainable development practices (Cavas, Acık, Koc, & Kolac, 2023).

Despite its growing importance, research indicates that students' understanding of ocean systems and human-ocean interactions is limited, primarily due to structural challenges in integrating ocean literacy into formal education. Key barriers include overloaded curricula, insufficient teacher expertise, and a lack of instructional resources. Studies show that while teachers recognize the importance of marine science education, they often do not cover these topics extensively in their lessons, citing a need for increased knowledge and resources as critical areas for improvement (Freitas, Bellgrove, Venzo, & Francis, 2022; Freitas, Venzo, Bellgrove, & Francis, 2025). Programs like the Blue School initiative demonstrate potential by fostering interdisciplinary approaches and community engagement, yet they also face challenges such as resource constraints (Costa & Faria, 2025). Furthermore, the ocean literacy movement emphasizes the necessity of inclusivity and accessibility, advocating for broader participation beyond traditional educational frameworks to enhance public understanding and engagement with marine environments (Worm et al., 2021). Addressing these challenges is essential for fostering a more informed and responsible relationship with the ocean (Borja et al., 2020).

In response to these challenges, a variety of student-centered instructional approaches, including inquiry-based, project-based, and problem-oriented learning, have been shown to effectively promote ocean literacy by enhancing student engagement, conceptual understanding, and environmental awareness. For instance, a project in Brazil demonstrated that integrating local contexts through theoretical lessons, field trips, and experiments significantly increased student engagement and positive attitudes towards ocean issues (Pazoto, Duarte, & Silva, 2023). Similarly, a study among Chinese university students revealed that emotional connectedness and experiential learning were crucial in fostering pro-environmental behaviors, highlighting the importance of interactive educational practices (Wang, Gao, Chang, & Zhang, 2025). Furthermore, initiatives like the Blue School Program in Portugal illustrate the benefits of a holistic approach that combines scientific, cultural, and ethical dimensions, leading to increased community involvement and partnerships (Costa & Faria, 2025). Collectively, these studies underscore the necessity of comprehensive educational interventions to cultivate a deeper understanding of ocean dynamics and promote sustainable behaviors across diverse educational settings (Mokos, Realdon, & Čižmek, 2020). However, the extent to which these approaches are effectively implemented and evaluated in formal education remains unclear.

Previous systematic and bibliometric reviews on ocean literacy have highlighted the increasing research interest and thematic development in this field. For example, Asikin, Suwono, Sumitro, and Dharmawan (2025) emphasize the growing integration of ocean literacy in science education, while Paredes-Coral et al. (2021) focus on global research mapping and interdisciplinary collaboration. Similarly, Salazar-Sepúlveda et al. (2023) identify a rapid increase in publications related to marine conservation and environmental awareness. Despite these contributions, most of these studies adopt descriptive or bibliometric perspectives, with limited attention to how instructional approaches are empirically implemented and evaluated in formal education settings. In particular, there is still a lack of systematic synthesis examining the effectiveness of instructional approaches based on measurable learning outcomes, such as pre–post evidence. Therefore, this study offers a novel contribution by focusing on the empirical effectiveness of instructional approaches, rather than merely describing research trends, thereby addressing the gap between theoretical recommendations and classroom practice.

Notably, although approaches such as problem-based and case-based learning approaches are often highlighted as effective for addressing complex socio-ecological issues, empirical evidence of their implementation in ocean literacy education remains scarce. Studies indicate that despite a general awareness of ocean literacy among educators, practical integration into curricula is lacking. For instance, a survey in the Azores revealed that 58% of teachers do not incorporate ocean-related themes into their teaching, underscoring a disconnect between awareness and practice (Freitas et al., 2025). Similarly, research in Australia found that while teachers recognize the importance of marine science, they infrequently cover these topics due to limited resources and knowledge (Freitas et al., 2022). Programs like the Blue School initiative demonstrate potential by fostering interdisciplinary engagement, yet challenges such as resource constraints persist (Costa & Faria, 2025). This indicates a concept–practice gap, where pedagogical models are widely recommended but not consistently applied or evaluated in real educational contexts. Furthermore, existing studies rarely provide comparative insights into how different instructional approaches contribute to ocean literacy outcomes,

particularly in terms of knowledge, attitudes, and pro-environmental behavior.

Therefore, a systematic and evidence-based synthesis is needed to examine not only the types of instructional approaches used in ocean literacy education, but also their pedagogical characteristics and effectiveness. Addressing this need, the present study conducts a systematic literature review focusing on instructional practices in formal education settings. This study aims to (1) identify instructional approaches used to promote ocean literacy, (2) analyze their key pedagogical characteristics, (3) evaluate their effectiveness based on reported learning outcomes, and (4) identify gaps to inform future research and curriculum development.

By integrating analysis of both instructional characteristics and empirical effectiveness, this study contributes to advancing a more comprehensive understanding of how ocean literacy can be effectively developed in formal education. In particular, it provides new insights into the relationship between instructional design and learning outcomes, while highlighting underexplored areas such as the limited application of problem-based learning in ocean literacy contexts.

Method

Research Method

This study employed a systematic literature review (SLR) to synthesize empirical evidence on instructional approaches used to promote ocean literacy in formal education. SLR is a rigorous method that enhances the quality, reliability, and transparency of research findings by systematically identifying, evaluating, and synthesizing relevant studies (Xiao & Watson, 2019). This study adopted the five-stage framework proposed by Denyer & Tranfield (2009) which has been widely used in educational research. The five stages include: (1) formulating research questions, (2) identifying relevant literature, (3) selecting and assessing studies based on predefined criteria, (4) extracting and analyzing data, and (5) synthesizing and reporting findings. The literature search was conducted in January 2026 using the Scopus database as the primary source. Scopus was selected due to its comprehensive coverage of peer-reviewed international publications. Reference management was conducted using Mendeley.

Research Questions

Research questions play a crucial role in defining the scope, direction, and analytical focus of a systematic literature review. In this study, the research questions were formulated to align with the available empirical evidence and to systematically examine instructional approaches used to promote ocean literacy in formal education contexts. Rather than focusing exclusively on predefined models, this review adopts a data-driven perspective to capture the range of instructional approaches reported in the literature. Accordingly, the following research questions are proposed:

RQ1. What instructional approaches are used to promote ocean literacy in formal school contexts, and how are these approaches implemented in practice?

RQ2. What are the key instructional characteristics of these approaches (e.g., learning activities, experiential components, and real-world integration), and how do they support the development of ocean literacy?

RQ3. How effective are these instructional approaches in improving ocean literacy outcomes, based on reported pre–post evidence?

RQ4. What gaps exist in the current research on ocean literacy instruction, particularly regarding underexplored approaches such as problem-based learning?

These questions are designed to provide a comprehensive understanding of both the effectiveness and pedagogical characteristics of instructional approaches, while also identifying critical gaps to inform future research and curriculum development in ocean literacy education.

Search Article & Inclusion Criteria

The second step in SLR involves finding, selecting, assessing, and listing core contributions related to the research question (Booth, Sutton, & Papaioannou, 2012). In this study, the Scopus database was used as the primary source due to its comprehensive coverage of peer-reviewed international publications. The search strategy was designed using a structured query to ensure relevance and consistency, namely: TITLE ("ocean literacy" OR "marine literacy") AND (education OR learning OR teaching OR instruction). The search was limited to publications between 2016 and 2026 and included only final-stage, peer-reviewed journal articles written in English. These criteria were applied to ensure that the selected studies were recent, relevant, and met academic quality standards.

The study selection process followed the PRISMA framework, which includes four stages: identification, screening, eligibility, and inclusion (Gallagher et al., 2016). Studies were assessed based on predefined inclusion and exclusion criteria. Only empirical studies conducted in formal education settings, focusing on ocean literacy or marine-related

learning, involving instructional interventions, and reporting measurable learning outcomes (e.g., pre–post data) were included. Studies were excluded if they were conceptual or review papers, lacked instructional intervention, did not report measurable outcomes, or were conducted outside formal education contexts.

A total of 300 records were initially identified through database searching. After applying the publication year criteria (2016–2026), 260 records remained. During screening, non-original articles such as conference papers, book chapters, and review articles were excluded, resulting in 176 studies. Following the eligibility assessment, 164 studies were retained. Finally, four studies met all inclusion criteria and were included in the analysis.

Through this systematic process, only studies that met all criteria were included in the final analysis, ensuring that the review focused on evidence-based instructional practices and their effectiveness in promoting ocean literacy as it is shown in Figure 1.

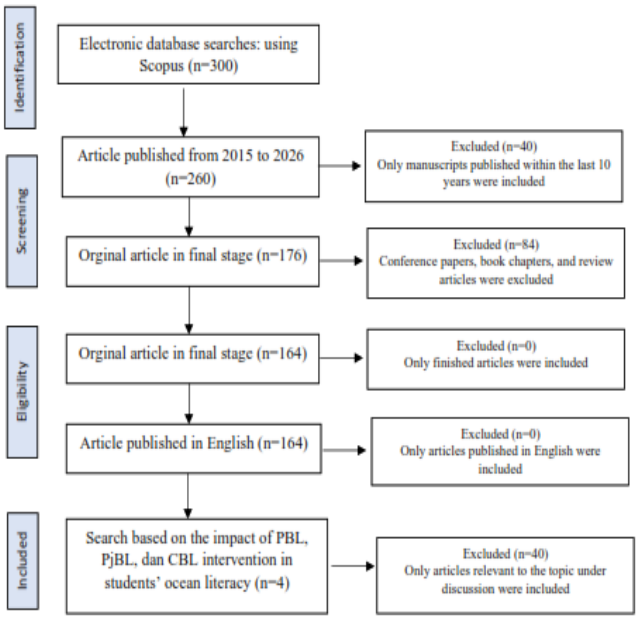

Figure 1. Flowchart of The Selection Process.

Result and Discussion

This section presents the findings of the systematic literature review, focusing on the instructional approaches used to promote ocean literacy, their pedagogical characteristics, and their effectiveness in improving learning outcomes. The results are organized in accordance with the research questions, beginning with the identification of instructional approaches, followed by an analysis of their key instructional features, and concluding with an evaluation of their effectiveness based on reported pre–post data.

A total of four empirical studies met the inclusion criteria and were included in the final analysis. These studies were conducted in formal education contexts and involved instructional interventions aimed at enhancing students' ocean literacy. The analysis reveals that inquiry-based learning (IBL) is the most consistently implemented approach across the selected studies, while project-based learning (PjBL) appears in a more limited and context-dependent manner. Notably, no empirical studies explicitly implementing problem-based learning (PBL) or case-based learning (CBL) were identified, despite their frequent mention in the literature.

The findings further indicate that the effectiveness of instructional approaches is closely associated with the nature of learning activities, particularly the inclusion of experiential and context-based components such as fieldwork, hands-on investigations, and real-world problem engagement. These instructional characteristics play a critical role in supporting the development of ocean literacy across multiple dimensions, including knowledge, attitudes, and pro-environmental behavior.

To provide a clearer overview, the results are presented in two main tables. Table 1 summarizes the effectiveness of instructional approaches based on pre–post outcomes and their interpreted impact levels, while Table 2 outlines the pedagogical characteristics of each study, including learning activities, instructional design, and ocean literacy principles addressed.

Table 1. Effectiveness of Instructional Models in Improving Ocean Literacy

No	Study	Educational Level	Instructional Model	Pre–Post Outcome	Statistical Significance	Effect Level
1	Italian OL assessment	Primary & Secondary	Project-Based Learning (PjBL)	Primary: 56.9 → 60.7Secondary: 55.9 → 57.0	Primary: significantSecondary: not significant	Moderate
2	Citizen science-based	Secondary	Inquiry-Based Learning	Increase from low–moderate to higher levels	Significant ($p < 0.001$)	High

No	Study	Educational Level	Instructional Model	Pre–Post Outcome	Statistical Significance	Effect Level
	learning		(IBL) + Citizen Science			
3	Fishworkshop (Uehara et al., 2025)	Primary & Secondary	Inquiry-Based Learning (IBL) with experiential learning	Knowledge: ~1.6–2.3 → ~2.6–4.0Attitude/behavior: ~3.5–4.4 → ~3.6–4.4	Mostly significant ($p < 0.05$)	High
4	Residential marine field course (Winks et al., 2020)	Upper secondary	Inquiry-Based Learning (IBL) with field-based experience	Cognitive (+24.8%) Behavioral (+25.4%) Affective (+20.9%)	Not inferentially tested (consistent increase)	Moderate–High

Table 1 summarizes the effectiveness of instructional approaches in promoting ocean literacy based on pre–post outcomes and their interpreted impact levels. The findings indicate that inquiry-based learning (IBL) consistently demonstrates high effectiveness, particularly when supported by experiential and context-based activities, leading to significant improvements in students' knowledge, attitudes, and pro-environmental behavior. In contrast, project-based learning (PjBL) shows moderate and less consistent effectiveness, despite covering a broader range of ocean literacy principles. Notably, no empirical evidence of problem-based learning (PBL) or case-based learning (CBL) interventions was identified, highlighting a gap between theoretically proposed approaches and their practical implementation in ocean literacy education.

The findings of this review indicate that inquiry-based learning (IBL) is the most consistently implemented instructional approach in ocean literacy education within formal school contexts. Across the selected studies, IBL is characterized by active student engagement through investigation, observation, and exploration of real-world marine phenomena. Such inquiry-oriented practices have been shown to enhance students' scientific understanding and engagement through investigative and hands-on activities (Boaventura et al., 2021; Niedoszytko, Wojcieszek, Podlesińska, & Borowiak, 2019). In addition, inquiry-based approaches support the development of critical thinking and motivation, which are essential components of effective science learning (Sam, 2024). This dominance of inquiry-based learning also reflects constructivist principles, which emphasize active knowledge construction through exploration and interaction with real-world contexts

Although prior literature frequently emphasizes a range of student-centered approaches—including inquiry-based, project-based, and problem-based learning—as relevant for environmental and ocean education (Salazar-Sepúlveda et al., 2023; Halawa, Lin, & Hsu, 2024), the present findings reveal that actual classroom implementation remains concentrated on inquiry-based approaches. While holistic initiatives such as the Blue School Program demonstrate the potential of interdisciplinary and community-based learning (Costa & Faria, 2025), empirical classroom-based studies still show limited diversification of instructional models. In contrast, project-based learning (PjBL) appears less frequently and is more context-dependent (Blázquez, Padrón, Badimón, & Lozano, 2023), and no empirical evidence of problem-based learning (PBL) or case-based learning (CBL) was identified. This pattern indicates a gap between theoretically recommended instructional approaches and their practical implementation in ocean literacy education.

Table 2. Characteristics of Instructional Practices and Ocean Literacy Integration

No	Study	Educational Setting	Instructional Model	Key Learning Activities	Ocean Literacy Principles Addressed
1	Italian OL assessment	Formal (primary & second	Project-Based Learning (PjBL)	Project construction (e.g.,	P1–P7 (comprehensive but

No	Study	Educational Setting	Instructional Model	Key Learning Activities	Ocean Literacy Principles Addressed
		ary school)		ship models), experiments, collaborative group work	uneven coverage)
2	Citizen science-based learning	Formal + non-formal integration	Inquiry-Based Learning (IBL) + Citizen Science	Field observation, data collection, data reporting to platforms, presentation	P5, P6 (dominant)
3	Fish workshop (Uehara et al., 2025)	Formal (primary & secondary school)	Inquiry-Based Learning (IBL) with experiential learning	Hands-on fish processing (filleting), contextual discussion, reflection on marine resources and consumption	P6 (dominant), P5 (strong), P4–P2 (partial)
4	Residential marine field course (Winks et al., 2020)	Formal (upper secondary, field-based program)	Inquiry-Based Learning (IBL) with field-based experience	Ecological fieldwork (transects, sampling), data analysis, group discussion, reflective activities	P6 (dominant), P5 (strong), P3–P2 (moderate)

Table 2 presents the pedagogical characteristics of the instructional approaches, including learning activities, instructional design, and ocean literacy principles addressed. The results show that effective instruction is characterized by active, student-centered, and experiential learning, where students engage in fieldwork, investigations, data collection, and real-world problem exploration. These activities are strongly aligned with inquiry-based processes and contribute to deeper cognitive, affective, and behavioral outcomes. The instructional focus is predominantly on marine biodiversity (Principle 5) and human–ocean interactions (Principle 6), indicating an emphasis on ecological understanding and socio-environmental awareness, while suggesting the need for more balanced coverage across all ocean literacy principles.

The effectiveness of instructional approaches is strongly influenced by their pedagogical characteristics, particularly the extent to which they incorporate experiential and context-based learning. The reviewed studies consistently demonstrate that effective instruction involves active, student-centered learning environments in which students engage in fieldwork, hands-on investigations, and collaborative inquiry processes. Such experiential learning activities enable direct interaction with marine systems and contribute to deeper conceptual understanding as well as affective engagement.

Previous studies have similarly emphasized the importance of contextual and experiential learning in enhancing environmental awareness. For instance, integrating local contexts through field-based and laboratory activities has been shown to increase student engagement and foster more meaningful learning experiences (Pazoto et al., 2023). In addition, emotional connectedness developed through experiential learning plays a crucial role in shaping pro-environmental attitudes and behaviors (Wang et al., 2025). Teacher-focused studies also highlight that incorporating local and contextual elements into instruction is essential for effectively delivering ocean literacy concepts (Freitas et

al., 2025). Furthermore, experiential and interdisciplinary learning environments, such as field courses and marine science programs, have been associated with both cognitive and professional development outcomes (Sims et al., 2021; Aliu, McKay, Welch-Devine, & Bledsoe, 2025). This pattern is consistent with experiential learning theory, which highlights the importance of direct experience and reflection in facilitating deeper cognitive and affective learning

The present findings extend these insights by demonstrating that instructional effectiveness is less dependent on the formal classification of the instructional model and more on the degree of authentic engagement embedded within the learning process. In other words, approaches that provide meaningful interaction with real-world contexts tend to produce stronger learning outcomes regardless of whether they are labeled as IBL or PjBL.

In terms of content coverage, instructional practices predominantly address ocean literacy principles related to marine biodiversity and human–ocean interactions. Similar patterns have been reported in curriculum-based studies, which indicate that certain ocean literacy principles receive greater emphasis than others (Chang, Hirenkumar, & Wu, 2021). Additionally, limited integration of ocean-related topics into formal curricula has been identified as a persistent challenge in several educational contexts (Freitas et al., 2025; Winks, Ward, Zilch, & Woodley, 2020). This suggests that current instructional practices may not fully reflect the multidimensional nature of ocean literacy.

The analysis of pre–post learning outcomes indicates that inquiry-based learning demonstrates the highest level of effectiveness in improving ocean literacy across cognitive, affective, and behavioral domains. In particular, interventions that integrate experiential components—such as fieldwork and citizen science—have been shown to significantly enhance students' understanding of marine-related issues (Boaventura et al., 2021; Kevrekidis et al., 2024). Hands-on and context-based learning activities also contribute to increased student engagement and more positive attitudes toward ocean conservation (Pazoto et al., 2023). Furthermore, emotional connectedness developed through experiential learning plays an important role in fostering pro-environmental behavior (Wang et al., 2025). From a theoretical perspective, these outcomes can be explained by the integration of experiential and inquiry-based processes, which enhance both conceptual understanding and behavioral engagement

These findings reinforce the argument that experiential and inquiry-based approaches are particularly effective in promoting holistic ocean literacy outcomes. Unlike earlier studies that primarily rely on descriptive or theoretical discussions, the present study provides an evidence-based synthesis by examining empirical pre–post data. This allows for a more robust evaluation of instructional effectiveness across different approaches.

In contrast, project-based learning demonstrates moderate and less consistent effectiveness. Although PjBL enables broader coverage of ocean literacy content, its impact on measurable learning outcomes varies across contexts. This suggests that instructional effectiveness is more strongly influenced by the depth of experiential and contextual engagement than by the instructional model itself.

A key finding of this review is the absence of empirical studies implementing problem-based learning (PBL) and case-based learning (CBL) in ocean literacy education. Although these approaches are widely recommended for addressing complex socio-ecological issues, their application in ocean literacy contexts remains limited. This indicates a clear concept–practice gap, where pedagogical approaches are theoretically promoted but not systematically implemented in classroom practice.

In addition, the findings reveal that current instructional practices tend to focus on a limited range of ocean literacy principles, particularly those related to biodiversity and human–ocean interactions. This pattern reflects broader challenges in integrating ocean literacy into formal education, including limited teacher capacity and insufficient instructional resources (Freitas et al., 2022; Freitas et al., 2025).

The findings have important implications for curriculum development and educational policy. The effectiveness of inquiry-based learning (IBL), particularly when combined with experiential activities, suggests that ocean literacy should be integrated through active, student-centered instructional designs. Curriculum development should ensure a more balanced coverage of all ocean literacy principles, while educational policies need to support implementation through teacher training, resources, and interdisciplinary approaches. Additionally, the lack of empirical evidence on problem-based learning (PBL) and case-based learning (CBL) highlights the need for policy support to encourage the adoption of diverse instructional strategies.

Taken together, these findings suggest important directions for future research. Further studies should prioritize empirical investigations of instructional effectiveness, particularly through the implementation of underutilized approaches such as problem-based learning (PBL) and case-based learning

(CBL). Moreover, there is a need to develop instructional designs that integrate a broader range of ocean literacy principles in order to support a more comprehensive and balanced understanding of marine systems.

This study has several limitations that should be acknowledged. First, the review relied solely on the Scopus database, which may have limited the inclusion of relevant studies indexed in other databases such as Web of Science or ERIC. Second, the study only covered publications within the period of 2016 to 2026, which may exclude earlier foundational studies in ocean literacy education. Third, only English-language publications were included, potentially introducing language bias and excluding relevant research published in other languages. These limitations suggest that future research should adopt a broader search strategy, including multiple databases, wider publication periods, and multilingual sources to provide a more comprehensive understanding of instructional approaches in ocean literacy.

Conclusion

This study provides an evidence-based synthesis of instructional approaches for promoting ocean literacy in formal education. First, inquiry-based learning (IBL) emerges as the most consistently implemented approach, while project-based learning (PjBL) appears less frequently. Second, effective instructional practices are characterized by experiential and context-based activities that promote active student engagement. Third, IBL demonstrates the strongest impact on students' knowledge, attitudes, and pro-environmental behavior, whereas PjBL shows moderate effectiveness. Fourth, a significant research gap is identified, as no empirical evidence was found for problem-based learning (PBL) and case-based learning (CBL), indicating a clear concept–practice gap.

This study is limited by its reliance on a single database (Scopus), a restricted publication period (2016–2026), and the inclusion of only empirical studies with pre–post data. Future research should expand database coverage (e.g., Web of Science and ERIC), adopt experimental designs, and investigate underutilized approaches such as PBL and CBL. For practice, educators and curriculum developers are encouraged to integrate experiential learning and ensure a more balanced coverage of ocean literacy principles.

References

Aliu, J. O., McKay, S. K., Welch-Devine, M., & Bledsoe, B. (2025). Assessing outcomes of a field-oriented course in natural infrastructure. *International Journal of Sustainability in Higher Education*. https://doi.org/10.1108/IJSHE-07-2024-0484

Asikin, N., Suwono, H., Sumitro, S. B., & Dharmawan, A. (2025). Teaching ocean literacy in science education: a systematic review. *Environmental Education Research*. https://doi.org/10.1080/13504622.2025.2490227

Blázquez, A., Padrón, C., Badimón, E., & Lozano, E. (2023). *PROJECT-BASED LEARNING AS AN OPTIMAL LEARNING METHOD IN MARINE SCIENCES*.

Boaventura, D., Neves, A. T., Santos, J., Pereira, P. C., Luís, C., Monteiro, A., Cartaxana, A., Hawkins, S. J., Caldeira, M. F., & Ponces de Carvalho, A. (2021). Promoting Ocean Literacy in Elementary School Students Through Investigation Activities and Citizen Science. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.675278

Booth, A., Sutton, A., & Papaioannou, D. (2012). *Systematic Approaches to a Successful Literature Review*.

Borja, A., Santoro, F., Scowcroft, G., Fletcher, S., & Strosser, P. (2020). Editorial: Connecting People to Their Oceans: Issues and Options for Effective Ocean Literacy. In *Frontiers in Marine Science* (Vol. 6). Frontiers Media S.A. https://doi.org/10.3389/fmars.2019.00837

Cavas, B., Acık, S., Koc, S., & Kolac, M. (2023). Research trends and content analysis of ocean literacy studies between 2017 and 2021. *Frontiers in Marine Science*, *10*. https://doi.org/10.3389/fmars.2023.1200181

Chang, C. C., Hirenkumar, T. C., & Wu, C. K. (2021). The concept of ocean sustainability in formal education—comparative ocean literacy coverage analysis of the educational standards of India and the USA. *Sustainability (Switzerland)*, *13*(8). https://doi.org/10.3390/su13084314

Costa, R. L., & Faria, C. (2025). The Blue School Program: A Model for Holistic Ocean Literacy Education. *Sustainability (Switzerland)*, *17*(2). https://doi.org/10.3390/su17020661

Denyer, D., & Tranfield, D. (2009). *"Producing a Systematic Review." In The SAGE Handbook of Organizational Research Methods*. Sage.

Freitas, C., Bellgrove, A., Venzo, P., & Francis, P. (2022). Towards a 2025 National Ocean Literacy Strategy: Current Status and Future Needs in Primary Education. *Frontiers in Marine Science*, *9*. https://doi.org/10.3389/fmars.2022.883524

Freitas, C., Venzo, P., Bellgrove, A., & Francis, P. (2025). Diving into a sea of knowledge: empowering

teachers to enhance ocean literacy in primary schools through an ocean education training program. *Environmental Education Research*, *31*(2), 262–283. https://doi.org/10.1080/13504622.2024.2357342

Gallagher, K. E., Kadokura, E., Eckert, L. O., Miyake, S., Mounier-Jack, S., Aldea, M., Ross, D. A., & Watson-Jones, D. (2016). Factors influencing completion of multi-dose vaccine schedules in adolescents: A systematic review. *BMC Public Health*, *16*(1). https://doi.org/10.1186/s12889-016-2845-z

Glithero, D., Bridge, N., Paul, K., & McRuer, J. (2025). Ocean Decade Challenge 10 underscores social dynamics in marine sciences as critical to transforming human–ocean relationships. *ICES Journal of Marine Science*, *82*(3). https://doi.org/10.1093/icesjms/fsaf030

Halawa, S., Lin, T. C., & Hsu, Y. S. (2024). Exploring instructional design in K-12 STEM education: a systematic literature review. In *International Journal of STEM Education* (Vol. 11, Number 1). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1186/s40594-024-00503-5

Kevrekidis, T., Markos, A., Boubonari, T., Mogias, A., Malea, P., Apostoloumi, C., & Kevrekidou, A. (2024). Assessing the impact of an integrated educational program on Greek students' knowledge about coastal lagoons and attitudes towards marine environment conservation. *Marine Pollution Bulletin*, *202*. https://doi.org/10.1016/j.marpolbul.2024.116297

McKinley, E. (2024). Ocean literacy for an Ocean constitution. *Global Constitutionalism*, *13*(1), 25–28. https://doi.org/10.1017/S204538172300014X

Mokos, M., Realdon, G., & Čižmek, I. Z. (2020). How to increase ocean literacy for future ocean sustainability? The influence of non-formal marine science education. *Sustainability (Switzerland)*, *12*(24), 1–12. https://doi.org/10.3390/su122410647

Niedoszytko, G., Wojcieszek, D., Podlesińska, W., & Borowiak, K. (2019). Implementing Ocean Literacy Through the Bond of Informal and Formal Education. In *Exemplary Practices in Marine Science Education* (pp. 123–142). Springer International Publishing. https://doi.org/10.1007/978-3-319-90778-9_8

Paredes-Coral, E., Mokos, M., Vanreusel, A., & Deprez, T. (2021). Mapping Global Research on Ocean Literacy: Implications for Science, Policy, and the Blue Economy. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.648492

Pazoto, C. E., Duarte, M. R., & Silva, E. P. (2023). Promoting ocean literacy among students in Brazilian schools. *Marine Pollution Bulletin*, *197*. https://doi.org/10.1016/j.marpolbul.2023.115690

Salazar-Sepúlveda, G., Vega-Muñoz, A., Contreras-Barraza, N., Castillo, D., Torres-Alcayaga, M., & Cornejo-Orellana, C. (2023). Bibliometric Analysis on Ocean Literacy Studies for Marine Conservation. *Water (Switzerland)*, *15*(11). https://doi.org/10.3390/w15112095

Sam, R. (2024). Systematic review of inquiry-based learning: assessing impact and best practices in education. *F1000Research*, *13*, 1045. https://doi.org/10.12688/f1000research.155367.1

Sims, R. J., Tallapragada, M., Payton, T. G., Noonan, K., Prosser, K. L., & Childress, M. J. (2021). University Experiences of Marine Science Research and Outreach beyond the Classroom. *Integrative and Comparative Biology*, *61*(3), 1078–1088. https://doi.org/10.1093/icb/icab104

Wang, L., Gao, B., Chang, X., & Zhang, L. (2025). The promotive effect of ocean literacy on marine conservation behavior: A qualitative study based on Chinese university students. *PLOS ONE*, *20*(8 August). https://doi.org/10.1371/journal.pone.0323510

Winks, L., Ward, M., Zilch, J., & Woodley, E. (2020). Residential marine field-course impacts on ocean literacy. *Environmental Education Research*, *26*(7), 969–988. https://doi.org/10.1080/13504622.2020.1758631

Worm, B., Elliff, C., Fonseca, J. G., Gell, F. R., Serra-Gonçalves, C., Helder, N. K., Murray, K., Peckham, H., Prelovec, L., & Sink, K. (2021). Making ocean literacy inclusive and accessible. *Ethics in Science and Environmental Politics*, *21*, 1–9. https://doi.org/10.3354/esep00196

Xiao, Y., & Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. In *Journal of Planning Education and Research* (Vol. 39, Number 1, pp. 93–112). SAGE Publications Inc. https://doi.org/10.1177/0739456X17723971