ISET 12 (2026) Postgraduate School UNNES: 100-107
International Conference on Science, Education and Technology
e-ISSN 2964-4291
https://proceeding.unnes.ac.id/ISET

Designing the ECO-ITERATE Framework for Local Socio-Ecological Problem-Based Natural and Social Sciences Learning: A Systematic Integrative Review

Wahyu Ramdhani*, Wasino, Muzakki Basori

Postgraduate School, Universitas Negeri Semarang, Semarang, Indonesia

*Corresponding Author: wahyu.ramdhani@students.unnes.ac.id

Abstract. Elementary Natural and Social Sciences learning requires a pedagogical design that connects scientific concepts, social practices, local environmental conditions, evidence, and responsible action. Previous studies commonly examine scientific literacy, environmental literacy, local wisdom, problem-based learning, and socio-scientific issues as separate strands. This study integrates those strands and designs the ECO-ITERATE framework for elementary learning. A focused systematic integrative review was conducted on 13 peer-reviewed studies published from 2020 to June 2026, supported by the Indonesian IPAS curriculum, the PISA 2025 assessment framework, and PRISMA 2020 reporting principles. Sources were selected through relevance, methodological clarity, outcome relevance, and bibliographic verification criteria, then coded by educational level, local issue, learning approach, inquiry activity, literacy outcome, and evidence directness. The synthesis produced five design principles: local-problem anchoring; integration of scientific, social, environmental, data, and civic literacy; scaffolded evidence-based inquiry; evaluation linked with reflection and collective action; and iterative transfer and redesign. These principles were organized into ten stages: Engage, Connect, Observe, Investigate, Transform, Evaluate, Reflect, Act, Transfer, and Extend. ECO-ITERATE is proposed as a conceptually grounded, classroom-oriented framework that still requires expert validation, practicality testing, limited classroom trials, and comparative effectiveness research.

Keywords: ECO-ITERATE; integrated literacy; local socio-ecological problems; Natural and Social Sciences; systematic integrative review

INTRODUCTION

Natural and Social Sciences (Ilmu Pengetahuan Alam dan Sosial, IPAS) in Indonesian elementary education is intended to connect understanding of natural phenomena with social life, local culture, and responsible citizenship. The current Phase B curriculum requires students to explain natural processes, identify local conservation problems, understand roles and responsibilities in school, and relate local wisdom to present life (Kementerian Pendidikan Dasar dan Menengah, 2025). This architecture creates space for interdisciplinary learning, but integration remains superficial when science and social content are merely placed side by side without a common problem, common evidence, or a shared decision-making process.

The PISA 2025 framework strengthens this argument by framing science competence as the capacity to explain phenomena, evaluate inquiry and evidence, and use scientific information for decisions and action in personal, local, national, and global contexts (OECD, 2026). Scientific literacy therefore involves more than recalling concepts. It also includes interpreting data, judging information, considering consequences, and exercising environmental agency. Valladares (2021) similarly positions scientific literacy as participatory and socially transformative. At the elementary level, these broad expectations must be translated into concrete, safe, observable, and age-appropriate activities.

Local socio-ecological problems provide such contexts because they combine natural processes and human practices. Classroom waste, single-use plastic, puddles after rain, blocked drainage, excessive water use, declining schoolyard vegetation, and household energy habits are scientifically explainable, socially produced, environmentally consequential, and open to collective improvement. When these issues become learning anchors, students can observe evidence, connect causes with behaviour, compare alternatives, and participate in bounded action. Reviews show that environmental socio-scientific issues support scientific literacy, argumentation, and decision making, while local orientation and action are recurrent conditions in effective environmental education (Ardoin et al., 2020;

Högström et al., 2025; Kumar et al., 2024).

Problem-based learning, project-based learning, and STEAM projects offer mechanisms for investigating authentic issues. Elementary studies indicate that project-based and local-wisdom-oriented learning can strengthen scientific literacy when students work with contextual problems and produce evidence-informed solutions (Adriyawati et al., 2020; Restiani et al., 2023; Suryanti et al., 2024). Studies at other school levels report benefits for conceptual knowledge, environmental literacy, and science competence, although those findings must be transferred cautiously to elementary IPAS (Islam et al., 2025; Lubis et al., 2022; Pertiwi et al., 2024; Verawati & Wahyudi, 2024). Reviews of socio-scientific issue teaching also warn that teachers need explicit scaffolding because open problems, competing values, and evidence evaluation can be difficult to manage (Chen & Xiao, 2021; Hernández-Ramos et al., 2021).

Three gaps remain. First, scientific, environmental, social, data, and civic literacies are usually treated as separate outcomes even though local problems require them to operate together. Second, existing approaches often emphasise inquiry or product creation but do not make value reflection, collective action, transfer, and redesign equally explicit. Third, elementary teachers need an operational sequence that preserves authentic inquiry without creating excessive cognitive or assessment burden. This review therefore asks: (1) which design principles recur across verified research on local, socio-scientific, problem-based, and literacy-oriented learning; and (2) how can those principles be organised into an operational and empirically testable framework for elementary IPAS? The contribution is a bounded conceptual framework, not a claim of classroom effectiveness.

METHODS

This study used a focused systematic integrative review followed by conceptual framework design. The approach was selected because the available evidence includes systematic reviews, quasi-experiments, instructional development studies, and conceptual work with different outcomes and instruments. Meta-analysis was inappropriate because the interventions and outcome measures were not sufficiently homogeneous. PRISMA 2020 was used as a reporting principle for transparent identification, screening, and inclusion decisions, while integrative synthesis was used to connect empirical and conceptual evidence (Page et al., 2021).

The review scope was defined through population, interest, and context. The population was elementary learners or school-level evidence with explicit relevance to elementary implementation. The interest included local socio-ecological problems, socio-scientific issues, local wisdom, problem-based learning, project-based learning, inquiry, environmental education, and literacy development. The context was science, social studies, or integrated IPAS learning. Publications from 2020 to June 2026 were prioritised to maintain current relevance. Official curriculum and assessment documents were included only as supporting frameworks, not as empirical impact studies.

Table 1. Review protocol and evidence use

Component	Operational decision	Purpose
Sources	Peer-reviewed journal articles and systematic reviews; official curriculum and assessment documents as support.	Balance empirical evidence with curriculum and methodological alignment.
Inclusion	2020-June 2026; clear learning design; literacy-related outcome; local, environmental, or socio-scientific relevance; verifiable bibliographic identity.	Retain evidence directly relevant to framework design.
Exclusion	Higher education without transfer value; unclear methods; no learning outcome; generic environmental discussion; unverifiable source.	Prevent conceptual drift and unsupported claims.
Coding	Education level, problem context, learning approach, activity, literacy outcome, assessment, evidence directness, and design implication.	Create traceable links from source findings to framework components.
Synthesis	Open coding, category comparison, cross-study convergence, and translation into design principles and stages.	Produce an operational but testable conceptual framework.

Thirteen peer-reviewed studies met the substantive and bibliographic criteria. Three sources provided direct elementary intervention evidence; five provided transferable school-level evidence; and five were systematic or conceptual reviews. The Indonesian IPAS curriculum, the PISA 2025 framework, and PRISMA 2020 supported curricular, assessment, and reporting decisions. The review deliberately did not report large database totals because a stable export, deduplication file, and complete screening log were not available. This decision limits claims but prevents the appearance of precision without an auditable record.

Data analysis proceeded in four steps. First, each source was read for units of meaning related to local problems, learning activities, literacy outcomes, scaffolding, assessment, and action. Second, open codes were assigned and compared across sources. Third, convergent codes were organised into five design principles. Fourth, the principles were translated into stages that could be observed, implemented, and evaluated in elementary classrooms. Evidence directness was retained during interpretation: direct elementary evidence informed grade-level operationalisation; transferable evidence informed design possibilities; and systematic or conceptual evidence informed broader principles. No source was treated as proof that the proposed framework is effective.

RESULTS AND DISCUSSION

Discussion. Local Problems as Authentic Learning Anchors

The first synthesis theme is the use of local socio-ecological problems as the organising centre of learning. A problem is pedagogically useful when it is visible in students' surroundings, contains a relationship between natural processes and human practices, can be investigated safely, and allows a feasible response. This criterion excludes distant or highly technical issues that students cannot observe or influence. Suitable elementary contexts include classroom waste, plastic consumption, drainage, standing water, schoolyard vegetation, water use, and energy-saving habits. These contexts are not merely examples after concept teaching; they structure questions, evidence collection, explanation, judgment, and action.

This local anchoring supports relevance and epistemic responsibility. Students can compare claims with direct observations instead of relying only on opinion. They can also recognise that environmental conditions are shaped by habits, rules, and collective decisions. The result is a meaningful bridge between natural and social knowledge. However, locality alone does not guarantee quality. Teachers must define the problem boundary, ensure safety, provide accessible data sources, and prevent the activity from becoming a moral campaign without scientific inquiry.

Integrated Literacy as a Coordinated Performance

The second theme is the coordination of five literacy dimensions. Scientific literacy appears when students explain phenomena and use evidence. Social literacy appears when they identify habits, roles, rules, and consequences. Environmental literacy appears when they interpret impacts on living systems and resources. Data literacy appears when they record, represent, compare, and interpret observations. Civic literacy appears when they justify a position and participate in collective action. Integrated literacy does not erase these dimensions or reduce them to one score. It describes how they work together within one problem-solving trajectory.

Table 2. Operational dimensions of integrated literacy

Dimension	Observable indicator
Scientific	Explains causes and effects using relevant concepts and simple evidence.
Social	Identifies behaviours, roles, rules, and consequences associated with the problem.
Environmental	Interprets effects of human action on resources, ecosystems, and living organisms.
Data	Records, represents, compares, and interprets observations or simple measurements.
Civic	Justifies a position and participates in feasible, responsible collective action.

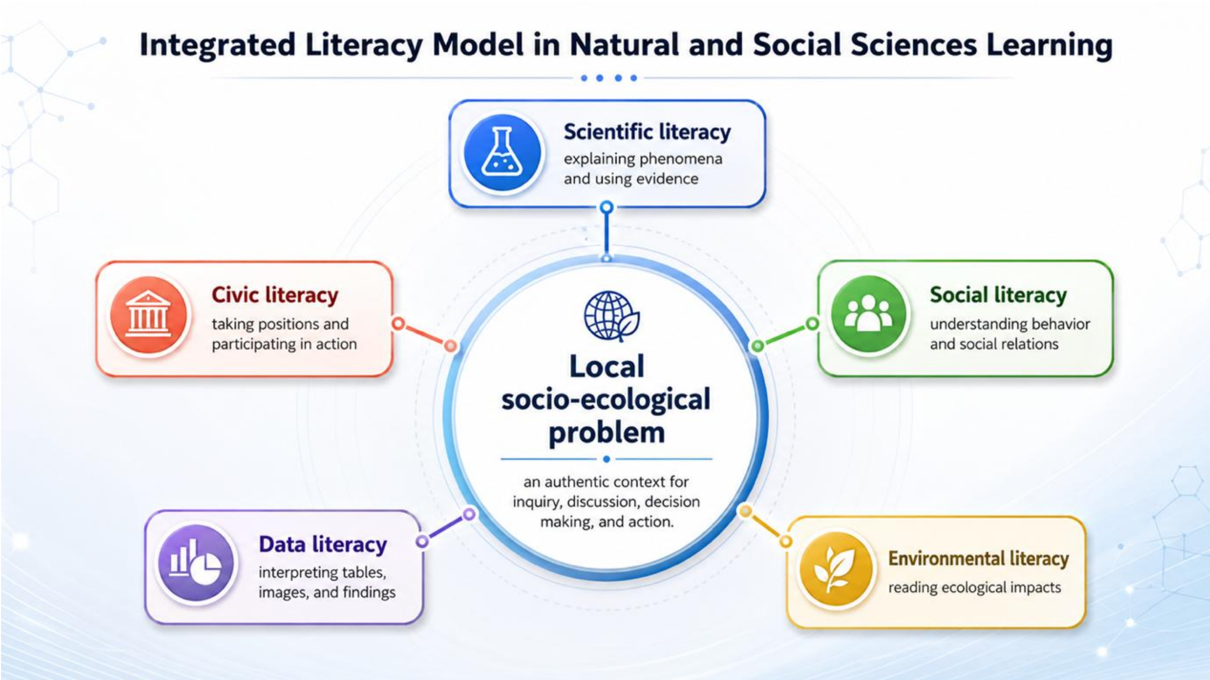

Figure 1. Integrated literacy dimensions organised around a local socio-ecological problem

Scaffolded Evidence-Based Inquiry

The third theme is evidence-based inquiry with explicit teacher support. Local learning should not stop at discussion. Students need structured opportunities to observe, count, compare, interview, document, and represent evidence. At elementary level, evidence can consist of tally marks, photographs, short interview notes, labelled maps, simple measurements, or before-and-after comparisons. These forms are sufficient when they answer a clear question and are interpreted carefully.

Scaffolding is essential because young learners may confuse observations with assumptions, collect irrelevant information, or propose solutions before analysing causes. Effective support includes guiding questions, observation sheets, sentence starters, concept maps, criteria for comparing alternatives, and short analytic rubrics. This is consistent with reviews showing that socio-scientific and problem-based learning requires teacher guidance, especially when students must evaluate evidence and negotiate social or ethical dimensions (Chen & Xiao, 2021; Hernández-Ramos et al., 2021).

Evaluation, Reflection, Action, and Iteration

The fourth and fifth themes concern the transition from explanation to responsible response. Students should compare alternatives based on evidence, safety, cost, benefit, and participation before acting. Reflection then makes values and responsibility explicit, while action provides a limited opportunity to apply the decision. Suitable actions include a class agreement, waste sorting, a short campaign, water-use monitoring, or schoolyard care. The action must remain proportionate to students' age and school authority. Transfer and redesign are necessary because a single activity does not demonstrate durable literacy. Students need to apply reasoning to another context, and teachers need to revise tasks, media, questions, or assessment from implementation evidence.

The ECO-ITERATE Framework

The five principles were organised into the ECO-ITERATE framework. Its ten stages form five iterative phases: Orientation (Engage and Connect), Inquiry (Observe and Investigate), Design and Judgment (Transform and Evaluate), Responsibility and Action (Reflect and Act), and Transfer and Improvement (Transfer and Extend). The sequence is explicit to reduce the openness that can make problem-based learning difficult for elementary students. Nevertheless, it remains adaptable: stages can be combined within a meeting, and the complete cycle can be distributed across four to six meetings.

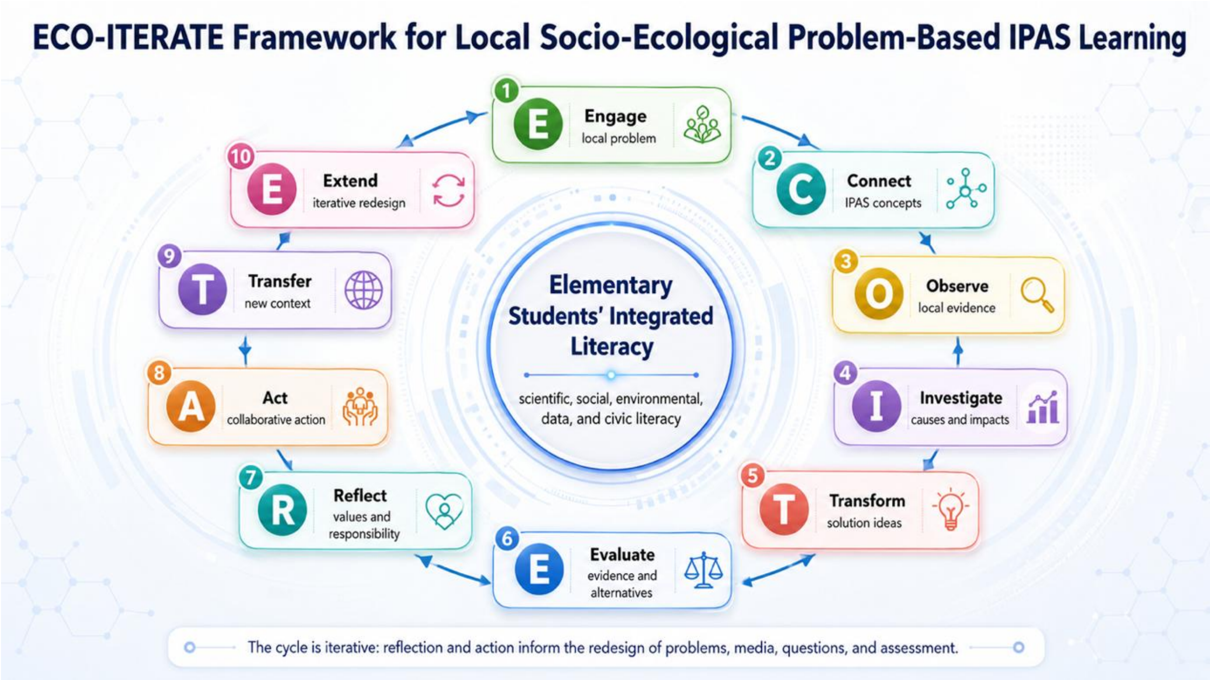

Figure 2. Five iterative phases and ten stages of the ECO-ITERATE framework

ECO-ITERATE differs from related approaches through the combination of local socio-ecological anchoring, evidence collection, evaluation of alternatives, value reflection, civic action, transfer, and instructional redesign. The framework does not claim to replace 5E, problem-based learning, project-based learning, socio-scientific issue learning, or education for sustainable development. It integrates selected strengths from those approaches to address a specific design problem in elementary IPAS. Its novelty therefore lies in the architecture and the coordinated literacy outcome, not in claiming that each individual stage is entirely new.

Table 3. ECO-ITERATE stages, functions, and outputs

Stage	Pedagogical function	Example activity	Expected output
Engage	Present an observable local issue.	Photo, short story, video, or direct school observation.	Curiosity and problem awareness.
Connect	Link the issue with IPAS concepts and social experience.	Concept map and discussion of habits or rules.	Science-social-environment connection.
Observe	Collect safe, simple local evidence.	Count, document, interview, map, or record.	Initial data and contextual evidence.
Investigate	Analyse causes, effects, actors, and patterns.	Cause-effect diagram and evidence comparison.	Evidence-based explanation.
Transform	Generate possible responses.	Poster, class rule, campaign, or simple tool design.	Alternative solution ideas.
Evaluate	Judge evidence, feasibility, safety, cost, and benefit.	Criteria matrix and reasoned comparison.	Justified decision.
Reflect	Examine values, responsibility, and limitations.	Reflection prompt or structured dialogue.	Value awareness and commitment.
Act	Implement a bounded collaborative response.	Waste sorting, water monitoring, or class agreement.	Documented class or school action.
Transfer	Apply reasoning to another setting or problem.	Home application or new local case.	Transfer of understanding.
Extend	Use implementation evidence to improve the next cycle.	Revise questions, media, tasks, or assessment.	Improved instructional design.

Illustrative Implementation

A feasible Grade IV or V scenario can use waste and environmental cleanliness across six meetings. Meeting 1 combines Engage and Connect through photographs and a concept map. Meeting 2 uses Observe to classify and count classroom waste. Meeting 3 combines Investigate and Transform through cause-effect analysis and solution design. Meeting 4 combines Evaluate and Reflect by comparing alternatives and writing commitments. Meeting 5 implements Act through a class agreement or sorting routine. Meeting 6 uses Transfer and Extend to connect learning with home practices and revise the learning design from student work and teacher notes.

Implementation quality depends on safeguards. Teachers should select a small, observable problem; combine related stages rather than creating ten separate lessons; use simple evidence tools; specify the boundaries of student action; and assess process, product, and reflection with complementary instruments. A written test alone cannot represent integrated literacy. Concept questions can assess explanation, observation records can capture evidence use, rubrics can assess products and decisions, and reflection journals can reveal values and transfer.

Distinctiveness and Assessment Alignment

ECO-ITERATE should be distinguished from related models by its design emphasis rather than by claiming complete novelty. The 5E learning cycle offers a strong sequence for conceptual science learning, but social behaviour, civic responsibility, and collective action are not always explicit. Problem-based learning begins with authentic problems and develops reasoning, yet it may become too open for elementary learners when evidence collection and decision criteria are weakly scaffolded. Project-based learning supports collaboration and concrete products, but the product can dominate the investigation if evidence use, value reflection, and evaluation of alternatives are not protected. Socio-scientific issue learning connects science, society, values, and decision making, although the issues selected for older students may be too abstract or contested for elementary classrooms. Education for sustainable development provides a broad ethical orientation, but teachers still need a short-cycle operational sequence. ECO-ITERATE combines these strengths around small, observable, and actionable school or community problems.

The framework also requires an assessment architecture aligned with its multidimensional outcome. Scientific, social, environmental, data, and civic literacy should first be scored through separate indicators because each dimension represents a different performance. Evidence may then be interpreted as a profile rather than immediately collapsed into a single total score. For example, a student may explain the cause of a drainage problem accurately but use data weakly, or may propose a socially acceptable action without considering environmental consequences. Analytic scoring makes such patterns visible and supports targeted feedback. A defensible assessment package therefore combines concept and evidence questions, structured observation, an analytic project or decision rubric, and a short reflection task. Triangulation is more appropriate than relying on one instrument because the framework includes knowledge, inquiry processes, judgment, participation, and transfer.

Several boundary conditions should guide future implementation. The framework is most appropriate when the problem can be observed safely, investigated with accessible evidence, and addressed through action within students' authority. It is less appropriate for hazards requiring specialist equipment, conflicts involving sensitive community groups, or issues for which students cannot obtain reliable information. Teacher readiness is another condition: teachers need sufficient content knowledge, confidence in guiding inquiry, and practical assessment tools. Time can be managed by combining stages, but removing Evaluate, Reflect, or Extend would weaken the distinctive logic of the cycle. Fidelity studies should therefore examine not only whether teachers mention each stage, but whether students actually collect evidence, justify decisions, reflect on responsibility, act within defined boundaries, and transfer reasoning to a new context.

Contribution and Validation Agenda

The theoretical contribution is a bounded construct of integrated literacy for elementary IPAS. It explains how scientific, social, environmental, data, and civic performances are coordinated by a local socio-ecological task while remaining analytically distinguishable. The practical contribution is a sequence that can be translated into lesson plans, student worksheets, problem banks, observation sheets, and analytic rubrics. Extend also makes reflective instructional improvement an explicit component rather than an informal follow-up.

Table 4. Sequential validation agenda

Phase	Required evidence	Decision focus
Expert validation	Ratings and comments from IPAS, curriculum, literacy, and elementary-learning experts.	Construct relevance, stage coherence, clarity, and age appropriateness.
Practicality test	Teacher readability, interview, time record, and implementation observation.	Feasibility within available time and resources.
Limited trial	Student work, observation notes, reflections, and teacher field notes.	Safety, comprehension, engagement, and task quality.
Comparative test	Pre-post tasks, analytic rubrics, fidelity evidence, and comparison data.	Measurable effects without overstating causality.

Limitations

The review has four limitations. The evidence corpus is focused rather than exhaustive, and dynamic database totals were not reported without a stable export and full screening log. Only three studies provided direct elementary intervention evidence; findings from other school levels were treated as transferable design evidence, not direct proof. The included interventions and outcome measures were heterogeneous, preventing meta-analysis. Finally, ECO-ITERATE has not yet undergone expert validation or classroom testing. These limitations narrow the claims but strengthen methodological honesty: the present result is a theoretically and empirically informed design proposition.

CONCLUSION

This systematic integrative review indicates that local socio-ecological problems can organise elementary IPAS learning when they are observable, conceptually connected, evidence based, socially and environmentally interpreted, and followed by justified action. The synthesis produced five principles local anchoring, integrated literacy, scaffolded inquiry, evaluation–reflection–action, and iterative transfer and organised them into ECO-ITERATE: Engage, Connect, Observe, Investigate, Transform, Evaluate, Reflect, Act, Transfer, and Extend. The framework contributes an explicit reasoning pathway that coordinates five analytically distinct literacy dimensions while maintaining age-appropriate scaffolding and bounded action. At this stage, ECO-ITERATE should be treated as a theoretically and empirically informed design proposition rather than an established effective model. Future studies should operationalise each literacy dimension through analytic indicators, document implementation fidelity at every stage, and use mixed evidence from concept tasks, student products, observations, and reflections. Validation should proceed sequentially from expert review and practicality testing to limited classroom trials and comparative studies across diverse contexts, while reporting teacher adaptations, time use, safety constraints, participation patterns, and transfer to new problems.

REFERENCE

Adriyawati, A., Utomo, E., Rahmawati, Y., & Mardiah, A. (2020). STEAM-project-based learning integration to improve elementary school students' scientific literacy on alternative energy learning. Universal Journal of Educational Research, 8(5), 1863–1873. https://doi.org/10.13189/ujer.2020.080523

Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. Biological Conservation, 241, 108224. https://doi.org/10.1016/j.biocon.2019.108224

Chen, L., & Xiao, S. (2021). Perceptions, challenges and coping strategies of science teachers in teaching socioscientific issues: A systematic review. Educational Research Review, 32, 100377. https://doi.org/10.1016/j.edurev.2020.100377

Hernández-Ramos, J., Pernaa, J., Cáceres-Jensen, L., & Rodríguez-Becerra, J. (2021). The effects of using socio-scientific issues and technology in problem-based learning: A systematic review. Education Sciences, 11(10), 640. https://doi.org/10.3390/educsci11100640

Högström, P., Gericke, N., Wallin, J., & Bergman, E. (2025). Teaching socioscientific issues: A systematic review. Science & Education, 34, 3079–3122. https://doi.org/10.1007/s11191-

024-00542-y

Islam, A. Z., Rachmadiarti, F., & Indana, S. (2025). Integrating local environmental issues into a problem-based learning e-book to improve students' science competencies. JPBI (Jurnal Pendidikan Biologi Indonesia), 11(2), 511–523. https://doi.org/10.22219/jpbi.v11i2.40907

Kementerian Pendidikan Dasar dan Menengah. (2025). Capaian pembelajaran Ilmu Pengetahuan Alam dan Sosial (IPAS) Fase B. https://guru.kemendikdasmen.go.id/kurikulum/referensi-penerapan/capaian-pembelajaran/sd-sma/ilmu-pengetahuan-alam-dan-sosial-ipas/fase-b/

Kumar, V., Choudhary, S. K., & Singh, R. (2024). Environmental socio-scientific issues as contexts in developing scientific literacy in science education: A systematic literature review. Social Sciences & Humanities Open, 9, 100765. https://doi.org/10.1016/j.ssaho.2023.100765

Lubis, S. P. W., Suryadarma, I. G. P., Paidi, & Yanto, B. E. (2022). The effectiveness of problem-based learning with local wisdom oriented to socio-scientific issues. International Journal of Instruction, 15(2), 455–472. https://doi.org/10.29333/iji.2022.15225a

OECD. (2026). PISA 2025 assessment and analytical framework. OECD Publishing. https://doi.org/10.1787/86c36975-en

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

Pertiwi, T. U., Oetomo, D., & Sugiharto, B. (2024). The effectiveness of STEM Project-Based Learning in improving students' environmental literacy abilities. JPBI (Jurnal Pendidikan Biologi Indonesia), 10(2), 476–485. https://doi.org/10.22219/jpbi.v10i2.33562

Restiani, N. L. D., Margunayasa, I. G., & Paramita, M. V. A. (2023). Improving scientific literacy of elementary school students through problem-based learning model with Balinese local wisdom. Jurnal Ilmiah Sekolah Dasar, 7(4), 590–598. https://doi.org/10.23887/jisd.v7i4.62080

Suryanti, Nursalim, M., Choirunnisa, N. L., & Yuliana, I. (2024). STEAM-Project-based learning: A catalyst for elementary school students' scientific literacy skills. European Journal of Educational Research, 13(1), 1–14. https://doi.org/10.12973/eu-jer.13.1.1

Valladares, L. (2021). Scientific literacy and social transformation. Science & Education, 30(3), 557–587. https://doi.org/10.1007/s11191-021-00205-2

Verawati, N. N. S. P., & Wahyudi. (2024). Raising the issue of local wisdom in science learning and its impact on increasing students' scientific literacy. International Journal of Ethnoscience and Technology in Education, 1(1), 42–54. https://doi.org/10.33394/ijete.v1i1.10881