European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available online at: www.oapub.org/edu

DOI: 10.46827/ejes.v13i10.7040 Volume 13 | Issue 10 | 2026

ALIGNING CURRICULUM, INQUIRY, AND ENVIRONMENTAL ACTION: AN EVIDENCE-INFORMED PROJECT-BASED INSTRUCTIONAL FRAMEWORK FOR GRADE 4 SCIENCE

Nguyen Thi Thu Hang[1],
Nong Thi Hoi[2i]
[1]Faculty of Primary Education,
Thai Nguyen University of Education,
Thai Nguyen University,
Vietnam
[2]Phu Binh 2 Primary School,
Phu Binh Commune,
Thai Nguyen Province,
Vietnam

Abstract:
Environmental education in primary schools is increasingly expected to connect disciplinary learning with students' capacity to investigate and respond to environmental issues. Project-based learning (PjBL) can support this integration, but its value depends on coherent alignment among curriculum requirements, scientific inquiry, age-appropriate environmental action, classroom feasibility, and assessment. This theory-informed descriptive study develops a proposed instructional framework for Grade 4 Science by integrating three evidence sources: international scholarship on environmental education and project-based science learning, analysis of the Vietnamese Grade 4 Science curriculum under the 2018 General Education Curriculum, and a cross-sectional needs-analysis survey of 80 primary teachers from Thai Nguyen and Cao Bang provinces. Teachers strongly endorsed environmental education (M = 4.32–4.55 across six perception items), yet PjBL was the least frequently used surveyed method (M = 2.74, SD = 0.94), and 67.5% had organized a Grade 4 Science project no more than once during the previous two school years. The most frequently reported barriers were limited instructional time (76.3%), lack of project exemplars and practical guidance (70.0%), and difficulty assessing individual contributions (65.0%). Assessment was knowledge-dominant: 73.8% reported using knowledge questions or tests, compared with 30.0% using process checklists and 25.0% using behavioral observation. Integrating these needs with curriculum and research-based design principles, the study proposes a three-dimensional Curriculum–Inquiry–Action Alignment Framework, operationalized through five design principles, a five-stage instructional cycle, and three implementation

[i] Correspondence: email hangntt@tnue.edu.vn

supports: scaffolded collaboration, flexible learning ecologies, and multi-source assessment. The framework is evidence-informed and practice-oriented; classroom implementation and empirical validation remain priorities for subsequent research.

Keywords: environmental education; project-based learning; primary science education; scientific inquiry; curriculum alignment; environmental action

1. Introduction

Environmental education has moved progressively from a narrow emphasis on environmental knowledge toward a broader concern with values, competencies, participation, and action. UNESCO's Education for Sustainable Development roadmap places particular emphasis on educator capacity, learning environments, youth engagement, and locally meaningful action (UNESCO, 2020). This orientation has direct implications for primary education: environmental learning should not end when students can name an environmental problem; it should help them use disciplinary knowledge to investigate situations, make reasoned decisions, and participate in age-appropriate action.

Research supports this multidimensional view. Ardoin et al. (2018), reviewing K–12 environmental education research, identified outcomes that extend across knowledge, attitudes, skills, behavior, academic learning, and personal and social development. Ardoin and Bowers (2020) similarly showed that environmental education for younger learners is most promising when it is experiential, locally grounded, and connected to meaningful participation. Evidence also cautions against assuming a simple progression from knowing to doing: environmental knowledge alone has limited explanatory power for ecological behavior, while experiential and affective dimensions such as connectedness with nature may be important (Otto & Pensini, 2017; Liefländer et al., 2013).

Project-based learning (PjBL) offers a potentially productive response because it can organize disciplinary learning around meaningful questions, sustained inquiry, collaboration, decision-making, product creation, reflection, and communication. In science education, Krajcik and Blumenfeld (2006) conceptualize project-based learning around driving questions, investigation, collaboration, disciplinary practices, and artifacts that make learning visible. Kokotsaki et al. (2016) further emphasize teacher scaffolding, effective group work, student autonomy, appropriate technology, and assessment aligned with project goals.

However, the presence of a project label does not by itself ensure high-quality learning. Systematic evidence at kindergarten and elementary levels remains mixed, and methodological reviews have highlighted weak reporting of instructional guidance, assessment tools, group-work preparation, and intervention fidelity (Ferrero et al., 2021). These concerns are especially relevant in primary classrooms, where extended projects can place substantial demands on planning, monitoring, role coordination, and synthesis.

Younger learners therefore benefit from explicit cognitive, procedural, and collaborative scaffolds. The central issue is not simply whether PjBL is beneficial, but under what design and implementation conditions it can connect environmental action with rigorous science learning.

This problem is particularly salient in Vietnam following recent curriculum reforms. The 2018 General Education Curriculum positions Grade 4 Science as a subject that explicitly develops three core scientific competencies: scientific knowledge, inquiry into the surrounding natural environment, and the practical application of learned knowledge and skills (Ministry of Education and Training [MOET], 2018). Environmental protection is integrated through key topics including water, air, noise, plants, animals, and food-chain relationships. Recent Vietnamese studies have also identified project-based learning as a promising approach for environmental protection education in primary schools (Nguyen & Ngo, 2024) and have reported that Grade 4 Science teachers generally value project-based approaches but do not use them regularly because of procedural, time, and implementation difficulties (Nguyen & Le, 2024). A 2026 study similarly reported positive teacher attitudes toward integrating environmental education with project-based instruction, while noting uneven attention to knowledge, skills, attitudes, and action (Nguyen & Nguyen Ngoc Nhu, 2026).

The present study responds to this challenge by combining theory-informed analysis with empirical evidence from 80 teachers who had taught or were teaching Grade 4 Science in two northern Vietnamese provinces (Thai Nguyen and Cao Bang). Rather than testing student outcomes, the study functions as a needs-analysis and design-development study focused on the conditions required for coherent project-based environmental education in primary science. It addresses three questions:

1) How do teachers perceive environmental education, and how frequently do they use project-based learning in Grade 4 Science?
2) What barriers, assessment practices, and support needs characterize current implementation? and
3) What design requirements emerge when teacher-reported needs are integrated with Grade 4 Science curriculum requirements and research-based principles of project-based environmental education?

The study addresses three related gaps. First, existing discussions of environmental education and PjBL often establish the value of experiential, inquiry-oriented learning without specifying how environmental activity should remain accountable to disciplinary science outcomes. Second, process models of PjBL do not necessarily explain how scientific evidence should justify environmental action, leaving a risk that projects become craft, campaign, or information-collection activities. Third, practical implementation in primary classrooms requires age-appropriate structures for time, collaboration, individual accountability, and assessment. The contribution is therefore both empirical and conceptual. Empirically, the study documents a recognition–implementation gap in which teachers strongly endorse action-oriented environmental education but report limited PjBL use and weak process- and behavior-sensitive assessment. Conceptually, it proposes a three-dimensional alignment model in which effective environmental projects align (a) environmental issues with science curriculum outcomes, (b) project activity with scientific inquiry and evidence, and (c) environmental action with scientifically justified understanding. The novelty lies in the alignment relationships among these dimensions rather than in any single component considered in isolation.

2. Theoretical and Conceptual Foundations

2.1. Environmental education as knowledge, inquiry, and action

Environmental education has a multidimensional outcome structure. Knowledge is necessary because students require concepts and explanatory models to interpret environmental phenomena. Yet action-oriented environmental education also requires inquiry skills, attitudes of responsibility, decision-making, and opportunities to participate. Ardoin et al. (2018) demonstrate that environmental education can influence a broad range of outcomes, while Otto and Pensini (2017) show why factual understanding should not be assumed to translate automatically into ecological behavior. For primary science, this suggests an instructional sequence in which environmental action is not an add-on to disciplinary learning. Scientific ideas should help students identify a problem, collect or interpret evidence, explain why the problem matters, judge possible responses, and select an action appropriate to their age and context. Environmental education is therefore strongest when knowledge, inquiry, and action are mutually reinforcing rather than taught as separate components. This structure mirrors the three competency dimensions outlined in the Vietnamese 2018 General Education Curriculum for Science: (1) Scientific understanding, (2) Exploring the surrounding natural world, and (3) Applying scientific knowledge and skills to practical situations (MOET, 2018).

This distinction also protects science lessons from becoming purely moralistic or campaign-oriented. A message such as "protect plants" becomes disciplinary learning when students use knowledge about plant needs, food chains, habitats, or ecosystem relationships to explain what should be protected, why, and how. Conversely, science knowledge becomes environmentally meaningful when students can use it to make reasoned choices in authentic situations.

2.2. Project-based learning in primary science: The necessity of scaffolded autonomy

Project-based learning is particularly relevant to this integration because it can connect a meaningful problem with sustained disciplinary work. Krajcik and Blumenfeld (2006) describe project-based science as learning organized around a driving question, investigation, collaboration, and the creation of tangible products. Kokotsaki et al. (2016) emphasize that successful implementation depends on scaffolding, effective group work, an appropriate balance between student autonomy and teacher guidance, assessment aligned with goals, and supportive school conditions.

These conditions become more important with younger learners. Ferrero et al. (2021) caution that PjBL research in kindergarten and primary education is methodologically heterogeneous and that implementation details are frequently underreported. Grade 4 learners can engage productively in observation, discussion, hands-on investigation, and collaborative work, but extended projects may exceed their independent capacity to plan, monitor progress, coordinate roles, and synthesize evidence without support. Minimally guided, highly open-ended project work can therefore become fragmented activity rather than sustained disciplinary inquiry. In this study, primary-school PjBL is consequently conceptualized as scaffolded autonomy: students exercise meaningful choice and responsibility within explicit cognitive, procedural, safety, and collaboration structures.

In environmental education, project-based learning can provide a coherent structure for observation, investigation, planning, action, product development, communication, and reflection. Nguyen and Ngo (2024) proposed a project-based process for environmental protection education in Vietnamese primary schools, supporting the feasibility of this direction. Yet process descriptions alone do not resolve the practical questions teachers face: how to fit a project into curriculum time, how to distribute work fairly, how to prevent parental over-involvement, and how to assess science learning and environmental action without overloading the classroom.

2.3. The three-dimensional alignment problem

This article proposes that the quality of project-based environmental education in primary science depends on three forms of alignment.

First, *curricular alignment* requires the environmental issue, driving question, tasks, and product to serve explicit science learning outcomes. Without this alignment, a project can become an extracurricular campaign or craft activity that consumes time without advancing disciplinary learning.

Second, *epistemic alignment* requires the activities students perform to reflect meaningful scientific practices. Students should observe, collect information, compare evidence, explain relationships, or test simple ideas rather than merely search for slogans or decorate a product. The environmental issue should therefore generate a need for scientific reasoning.

Third, *action alignment* requires environmental action to arise from and demonstrate scientific understanding. Students' actions should be feasible, safe, observable, and appropriately connected to the problem. An action such as caring for a plant becomes educationally stronger when students can explain how watering, light, placement, or other care decisions respond to the plant's needs; protecting plants in a food-chain project becomes meaningful when students can explain consequences for other organisms.

The three dimensions are analytically distinct but pedagogically interdependent. Curricular alignment establishes what science understanding and competence the project is intended to develop; epistemic alignment specifies how students generate, examine, and use evidence; and action alignment requires students to justify feasible environmental responses using that scientific understanding. The framework can therefore be represented as a linked alignment system rather than a simple sequence. When all three dimensions are coherent, environmental action can serve as contextualized evidence of application. When one dimension is weak, project quality is compromised: curriculum without inquiry can become transmission, inquiry without action can remain detached from environmental responsibility, and action without curriculum and evidence can become symbolic or campaign-oriented.

Table 1: Three-dimensional alignment for project-based environmental education

Alignment dimension	Core question	Risk when weak	Design implication
Curricular alignment	What Grade 4 Science learning outcome does the project advance?	Environmental activity becomes an add-on or campaign.	Begin with curriculum outcomes before selecting the project.
Epistemic alignment	What evidence, inquiry, and scientific reasoning will students use?	Project becomes craft, information collection, or slogan production.	Require observation, data, explanation, comparison, or simple investigation.
Action alignment	How does scientific understanding inform a feasible environmental action?	Action is symbolic or disconnected from learning.	Make action age-appropriate, observable, and justified by science.

3. Method

3.1. Research design

The study used a theory-informed descriptive design with an evidence-to-design orientation. Three evidence streams were integrated:

a) relevant international scholarship on environmental education and project-based science learning, including implementation and assessment considerations;
b) analysis of Grade 4 Science requirements in the Vietnamese 2018 General Education Curriculum; and
c) a cross-sectional teacher survey used as a needs-analysis component.

The survey was not intended to establish causal relationships or population prevalence. Instead, it identified recognition–implementation gaps, practical barriers, assessment practices, and preferred forms of support that could be translated into design requirements for the proposed framework.

3.2. Participants and sampling procedure

A convenience and purposive sampling approach was used to recruit primary teachers who had previously taught or were currently teaching Grade 4 Science in northern Vietnam. The analytic sample comprised 80 teachers from Thai Nguyen province (n = 42, 52.5%) and Cao Bang province (n = 38, 47.5%). These provinces provided contrasting school and resource contexts, including urban, rural, and mountainous/disadvantaged settings; the sample should nevertheless be interpreted as context-specific rather than nationally representative. Fifty-five percent of participants had at least 11 years of teaching experience, and 80.0% had taught Grade 4 Science for at least two years. Only 36.3% reported prior training in PjBL, whereas 60.0% reported prior training related to environmental-protection education.

Table 2: Characteristics of the teacher sample (N = 80)

Characteristic	Category	n	%
Province	Thai Nguyen	42	52.5
Province	Cao Bang	38	47.5
Teaching experience	< 5 years	14	17.5
Teaching experience	5–10 years	22	27.5
Teaching experience	11–20 years	28	35.0
Teaching experience	> 20 years	16	20.0
Work context	Urban	18	22.5
Work context	Rural	34	42.5
Work context	Mountainous/disadvantaged	28	35.0
Grade 4 Science experience	< 2 years	16	20.0
Grade 4 Science experience	2–5 years	35	43.8
Grade 4 Science experience	> 5 years	29	36.2
Prior PjBL training	Yes	29	36.3
Prior PjBL training	No	51	63.8
Prior environmental-education training	Yes	48	60.0
Prior environmental-education training	No	32	40.0

3.3. Survey instrument and validation

The questionnaire contained four domains: participant characteristics; frequency of teaching-method use in Grade 4 Science and barriers to PjBL; teachers' perceptions and current approaches to environmental education; and practices related to project-based environmental education. The instrument combined 5-point Likert-type items with multiple-response items. Content was reviewed by three experts in primary science education before administration to examine relevance, clarity, and alignment with the study purposes. For the Likert-type perception and practice items treated as a combined internal-consistency set in the available dataset, Cronbach's α was 0.86. Because the questionnaire also contained heterogeneous frequency and multiple-response items, the reliability coefficient should not be interpreted as applying to those categorical items. Means (M) and standard deviations (SD) were used for Likert-type items. Frequencies and percentages were reported for multiple-response questions concerning barriers, potential project topics, assessment tools, and support needs; percentages for these items do not sum to 100%. The analyses are descriptive and no causal or population-level inference is claimed.

3.4. Curriculum and framework-development procedure

Curriculum analysis focused on Grade 4 Science requirements within the 2018 General Education Curriculum that connect scientific understanding with inquiry, application, or environmentally responsible action. Candidate areas included water protection, clean air, noise reduction, plant care, and the role of plants in food chains (MOET, 2018). Framework development followed an explicit evidence-to-design procedure. First, the literature was used to identify research-based requirements for meaningful PjBL, scientific inquiry, environmental action, scaffolding, and assessment. Second, curriculum requirements constrained project scope and protected disciplinary relevance. Third, survey findings identified implementation bottlenecks and teacher support needs. Finally, convergent requirements across these evidence streams were translated into design principles, a five-stage instructional cycle, and implementation supports. Table 3 summarizes this evidence-to-design logic.

Table 3: Evidence-to-design matrix for the proposed framework

Evidence / identified requirement	Design implication	Framework response
Literature: meaningful PjBL requires disciplinary inquiry, scaffolding, collaboration, reflection, and aligned assessment.	Avoid activity- or product-only projects; provide structured autonomy.	Epistemic alignment; scaffolded collaboration; five-stage instructional cycle.
Grade 4 Science curriculum: learning outcomes integrate scientific understanding, inquiry, and practical application.	Begin from explicit curriculum outcomes and retain disciplinary science goals.	Curriculum alignment; curriculum-first design principle.
Survey: instructional time was the most frequently reported barrier (76.3%).	Projects must be bounded, schedulable, and distributed across appropriate learning settings.	Five-stage cycle; flexible learning ecology.
Survey: teachers reported difficulties with individual contribution (65.0%) and group management (48.8%).	Make roles, milestones, and individual evidence visible.	Accountable collaboration; role cards; process evidence.
Survey: knowledge tests dominated assessment (73.8%), while process, behavioral, and rubric-based tools were less common.	Use complementary evidence for science understanding, inquiry, product/communication, and environmental action.	Multi-source, low-burden assessment architecture.

3.5. Research integrity and ethics

Participation in the teacher survey was voluntary. Participants were informed of the study purpose and consented before completing the questionnaire, and the dataset used for analysis was anonymized. No personally identifying information is reported.

4. Results: From Teacher Needs to Design Requirements

4.1. Strong recognition of environmental education, but limited project-based implementation

Teachers expressed very strong support for environmental education. The statement that environmental education is necessary in primary school received the highest mean (M = 4.55, SD = 0.57). Teachers also strongly endorsed linking environmental education to nearby family, school, and local issues (M = 4.51, SD = 0.60), direct student participation in environmental-protection activities (M = 4.49, SD = 0.66), multidimensional outcomes encompassing knowledge, attitudes, skills, and behavior (M = 4.41, SD = 0.67), the suitability of Grade 4 Science for environmental education (M = 4.39, SD = 0.68), and the need to assess both awareness and behavior (M = 4.32, SD = 0.74).

In contrast, project-based learning was the least frequently used of the surveyed Grade 4 Science teaching methods (M = 2.74, SD = 0.94). Observation (M = 4.31, SD = 0.72), questioning (M = 4.24, SD = 0.73), cooperative group learning (M = 4.15, SD = 0.81), and practical work or experiments (M = 4.08, SD = 0.84) were used much more often. This pattern suggests that teachers already use many component practices associated with active science learning, but do not frequently integrate them into a sustained project structure.

Table 4: Selected indicators of the recognition–implementation gap

Indicator	M	SD	Interpretive pattern
Environmental education is necessary in primary school	4.55	0.57	Very strong endorsement
Environmental education should link to local/family/school issues	4.51	0.60	Very strong endorsement
Students should directly participate in environmental action	4.49	0.66	Very strong endorsement
Grade 4 Science contains suitable environmental content	4.39	0.68	Very strong endorsement
Assessment should address awareness and behavior	4.32	0.74	Very strong endorsement
Use of PjBL in Grade 4 Science	2.74	0.94	Moderate frequency
Use of PjBL specifically for environmental education	2.69	1.03	Moderate frequency
Family/community coordination in environmental education	2.91	1.02	Moderate frequency

Frequency counts reinforce this interpretation. During the previous two school years, 23 teachers (28.8%) had never organized a Grade 4 Science project and 31 (38.8%) had done so only once. Thus, 67.5% of the sample had used PjBL no more than once over two years; only five teachers (6.3%) reported four or more uses. Taken together with the high perception ratings, these descriptive data indicate a recognition–implementation gap:

positive views of environmental education coexist with limited reported use of sustained project structures.

4.2. Teachers identify substantial curriculum potential

Teachers perceived multiple environmental themes as suitable for project development. Water and source protection was selected by 86.3%, air and air-quality protection by 83.8%, plants/animals/biodiversity by 78.8%, green-clean-beautiful school environments by 76.3%, waste sorting and recycling by 72.5%, sound/noise by 63.8%, and energy conservation by 45.0%. These percentages represent teachers' perceptions of topics they had used or considered suitable; they should not be interpreted as evidence that every item constitutes a separate Grade 4 Science curriculum strand.

The pattern nevertheless reveals an important design preference: teachers favored issues that are visible, local, and actionable. This is consistent with both environmental-education literature and Grade 4 learners' developmental needs. It also supports a curriculum-first framework in which projects are selected from science outcomes that can be investigated in the school, home, or immediate community.

4.3. Implementation barriers are primarily organizational and pedagogical

The most frequently reported difficulty was fitting projects into available instructional time (76.3%). This was followed by lack of project exemplars and practical guidance (70.0%), difficulty assessing individual contributions (65.0%), lack of confidence in designing and organizing projects (56.3%), and difficulty managing group work and project progress (48.8%). Student limitations in self-directed learning and collaboration were selected by 41.3%, while lack of materials, equipment, or funding (33.8%) and difficulty coordinating with families or communities (25.0%) were less frequently reported.

Table 5: Reported barriers to using project-based learning in Grade 4 Science

Barrier	n	%
Difficulty allocating instructional time	61	76.3
Lack of project exemplars and practical guidance	56	70.0
Difficulty assessing individual student contributions	52	65.0
Lack of confidence in designing and organizing projects	45	56.3
Difficulty managing group work and project progress	39	48.8
Students' limited self-directed learning/collaboration	33	41.3
Lack of materials, equipment, or funding	27	33.8
Difficulty coordinating with parents/community	20	25.0

The ordering of reported barriers suggests that implementation difficulties were not primarily material. Teachers more frequently selected the architecture of project work—time, design guidance, assessment, and management—than materials, equipment, or funding. For framework design, this pattern supports reducing procedural complexity, making project stages visible, providing manageable planning supports, and clarifying how science learning and individual participation can be documented.

4.4. Assessment reveals a method–assessment mismatch

Assessment was the clearest implementation bottleneck. Among teachers' reported project-assessment tools, knowledge questions or tests were dominant (73.8%). By contrast, only 33.8% used self- or peer assessment, 30.0% used process checklists, 25.0% used behavioral observation, and 22.5% used product rubrics. More than one quarter (27.5%) reported using no specific project-assessment tool.

Table 6: Assessment tools reported for project-based environmental education

Assessment tool	n	%
Knowledge questions/tests	59	73.8
Self-assessment/peer assessment	27	33.8
Process checklist	24	30.0
No specific assessment tool	22	27.5
Behavioral observation form	20	25.0
Product rubric	18	22.5

The same mismatch appears in teachers' reported implementation of project stages. Selecting a nearby environmental problem aligned with learning outcomes was the strongest of the surveyed project processes, yet reached only M = 2.65. The two weakest processes were evaluating both project process and product (M = 2.11) and tracking changes in students' environmental attitudes and behavior (M = 1.90). Teachers therefore endorsed behavior-sensitive environmental education more strongly than they reported using assessment practices capable of documenting process or action. This mismatch may create conditions in which environmental learning remains knowledge-dominant unless additional sources of evidence are incorporated into assessment.

4.5. Teachers primarily request practical design support

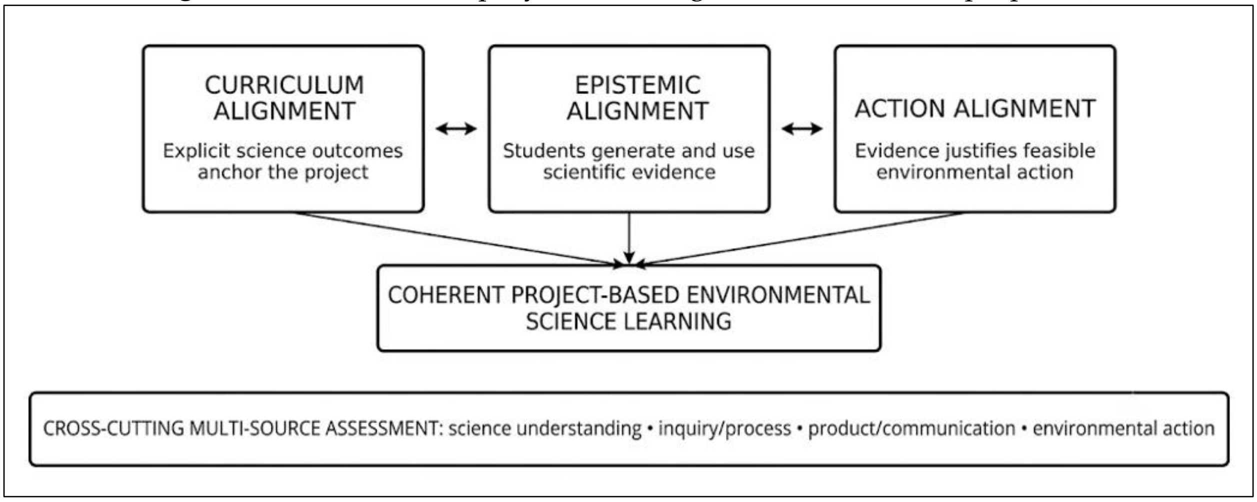
Teachers' support priorities closely matched their reported barriers. A clear, easy-to-apply instructional process was selected by 81.3%, Grade 4 Science project exemplars by 78.8%, and checklists/rubrics/observation forms by 72.5%. Task sheets, group plans, and project diaries were requested by 61.3%, while 53.8% selected professional development or subject-team learning. Materials/equipment/funding (38.8%) and mechanisms for parent/community coordination (23.8%) were lower priorities.

5. Proposed Instructional Framework

5.1. Framework architecture: curriculum–inquiry–action alignment

Integrating the theoretical literature, curriculum analysis, and teacher survey yields a proposed framework centered on three forms of alignment. The framework begins with explicit science curriculum outcomes, connects those outcomes to a local problem that creates a need for scientific inquiry, and uses inquiry-generated evidence to justify a feasible environmental response. Assessment is cross-cutting rather than terminal: evidence is gathered across scientific understanding, inquiry process, communication/product, and environmental action. Figure 1 represents these relationships as an alignment system rather than a validated causal model.

Figure 1: Curriculum–Inquiry–Action Alignment Framework (proposed)



5.2. Five design principles

Principle 1: Curriculum-first environmental integration

Every project should begin with explicit science learning outcomes (e.g., understanding plant needs, food chains, water properties) and environmental-education goals. Teachers should identify what students must understand and be able to do before choosing a project product. This prevents project work from becoming an extracurricular campaign, decorative poster task, or additional workload detached from curriculum learning.

Principle 2: Scientific inquiry should drive environmental action

Students should use observation, information gathering, comparison, simple investigation, or evidence-based explanation to understand the environmental issue before acting. The action should be a reasoned response to what students learn through science, not a predetermined slogan.

Principle 3: Environmental action should be authentic, age-appropriate, and safe

Actions should be feasible for 9-to-10-year-old primary students, observable within the project period, low-risk, and connected to their immediate environment (classroom, school ground, home). Students should not be asked to handle polluted water, hazardous waste, smoke, or unsafe traffic environments. The educational value lies in informed participation, not in exposing children to authentic hazards.

Principle 4: Autonomy should be guided and collaboration accountable

Primary students require structured scaffolds such as visual task sheets, role descriptions (e.g., Group Leader, Equipment Manager, Data Collector, Presenter), milestone checklists, and feedback. Group work should include individual responsibilities and evidence of contribution so that one student or an adult does not complete the project for the group.

Principle 5: Assessment should capture science, process, product, and action.

Assessment should be planned before the project begins and should gather complementary evidence rather than rely on a single product or test score. A short application task can assess scientific understanding; process checklists and diaries can document participation and inquiry; rubrics can assess product quality and communication; and brief observations or follow-up records can document environmental action. These evidence sources serve different purposes and should not be collapsed indiscriminately into one score.

5.3. Five-stage instructional cycle tailored to primary learners

To enhance practical classroom usability, the instructional framework is operationalized through a five-stage instructional cycle designed specifically for Grade 4 Science.

Table 7: Five-stage instructional cycle for project-based environmental education

Stage	Core teacher decisions & Scaffolding	Student activity (Grade 4 focus)	Primary evidence
1. Identify	Analyze 2018 Curriculum outcomes; frame a child-centric driving question (e.g., "How can we make our school water station clean and safe?").	Activate prior experience, observe local phenomena, discuss the problem, clarify project purpose.	Problem statement & driving question sheet
2. Plan	Define learning goals, safety boundaries, roles, timeline, and simplified rubric criteria; provide structured planning templates.	Form small groups (4–5 students), assign task cards, complete a group plan with teacher guidance.	Group plan, role cards, success criteria checklist
3. Investigate & Act	Provide inquiry scaffolds (observation sheets, safety rules); monitor group progress and ensure scientific evidence quality.	Observe, record simple data in diaries, test basic variables, apply science concepts, execute safe environmental action.	Inquiry data log, project diary, observed action
4. Explain & Communicate	Prompt evidence-based scientific explanations; organize peer feedback using structured prompts (e.g., "I like...", "I wonder...").	Present artifacts (posters, eco-models, green corners), justify action using science concepts, revise work based on feedback.	Presentation/artifact + verbal/written scientific explanation

5. Evaluate, Reflect & Continue	Gather multi-source assessment evidence; provide constructive feedback; encourage long-term green habit formation.	Self/peer evaluate using icon scales (smiley faces), reflect on personal contribution, select continuing personal eco-habits.	Science application task, process checklist, reflection log

5.4. Three implementation support systems

5.4.1. Scaffolded group work and differentiation

The first support system responds to teachers' concerns about group management, individual contribution, and students' limited self-regulation. Groups should remain small (4–5 students), and roles must be linked to concrete, observable tasks (e.g., Reader, Recorder, Presenter, Equipment Handler). Differentiated support is provided by adjusting template structure: struggling students receive structured fill-in-the-blank observation forms, while advanced students are prompted to formulate explanatory hypotheses for observed environmental changes.

5.4.2. Flexible learning ecology across classroom, school, home, and community

The second support system addresses time constraints. Core concept learning, data analysis, synthesis, and peer evaluation must remain within scheduled classroom hours. Short, safe observational tasks extend to the school grounds or home (e.g., monitoring home tap water leaks or plant growth). Parents are invited as supporters of safety and resource access, but explicit guidelines prohibit parental completion of student artifacts.

5.4.3. Multi-source, low-burden assessment architecture

The third support system replaces single-score testing with a streamlined four-part assessment bundle, preventing teacher overload while capturing holistic competency growth.

Table 8: Multi-source assessment architecture

Learning dimension	Suggested evidence & Tools	Assessment purpose
Scientific understanding	Short application task, labeled diagram, scenario explanation	Verify whether students grasp fundamental science concepts.
Inquiry & Process	Process checklist, inquiry diary, observation log	Track active participation, evidence gathering, and revision.
Product & Communication	Analytic product rubric (3 levels: Developing, Proficient, Advanced)	Evaluate clarity, scientific accuracy, and feasibility of artifacts.
Environmental Action	Brief behavioral checklist / teacher-peer observation log	Document observable ecological actions in daily school/home routines.

5.5. Exemplar Lesson Plan: "Our Green Corner – Caring for Primary Plants"

To illustrate how the proposed framework can be translated into classroom planning, an exemplar project is outlined in Table 9 for a Grade 4 Science topic concerning plant needs and care. The example is illustrative rather than an evaluated intervention.

Table 9: Exemplar Grade 4 Science project plan

Project Aspect	**Exemplar Implementation Details**
Curriculum Unit	Grade 4 Science - "Living Things and the Environment" (MOET 2018 Curriculum)
Driving Question	*"How can we design and care for a 'Green Corner' in our classroom so that our plants stay healthy and strong?"*
Stage 1: Identify	Students compare two similar potted plants under the same watering conditions but different light exposure, or under the same light conditions but different watering regimes. They formulate questions about one selected factor and plant health.
Stage 2: Plan	Groups choose a plant species, assign roles (Water Manager, Light Monitor, Leaf Inspector, Recorder), and complete a 1-week Plant Care Log template.
Stage 3: Investigate & Act	Over 7 days, groups conduct systematic observation focused on one selected factor (e.g., light exposure while watering is held comparable), record leaf condition and other observable indicators, and use the evidence to adjust safe plant-care decisions.
Stage 4: Explain & Communicate	Groups display their plant in the classroom "Green Corner" and present a short report explaining how their care actions directly responded to the plant's scientific needs.
Stage 5: Evaluate	The teacher uses a process checklist for group participation, a short application task on plant needs and care decisions, and an icon-based peer/self-review sheet. Students explain which observations justified their care actions.

6. Discussion

6.1. The recognition–implementation gap is primarily a design challenge

The survey identified a clear descriptive contrast between teachers' strong endorsement of environmental education (M = 4.32–4.55) and their relatively infrequent use of PjBL (M = 2.74). This pattern is consistent with the broader implementation concern highlighted in the PjBL literature: valuing active, authentic learning does not ensure that teachers have sufficient structures for sustained inquiry, group management, and aligned assessment (Kokotsaki et al., 2016; Ferrero et al., 2021). In the present sample, the most frequently reported barriers were time, lack of exemplars and guidance, and assessment of individual contribution. These findings suggest that professional learning focused only on environmental awareness would be insufficient. A more appropriate response is design-oriented professional support that helps teachers convert curriculum outcomes into bounded projects with visible stages, manageable evidence requirements, and feasible classroom routines.

6.2. Scaffolded autonomy as a condition for primary PjBL

The proposed framework treats autonomy as structured rather than unrestricted. This position aligns with the emphasis on teacher scaffolding, effective group work, and an appropriate balance between guidance and student responsibility in the PjBL literature (Krajcik & Blumenfeld, 2006; Kokotsaki et al., 2016). For Grade 4 learners, task cards, observable roles, milestone checks, safety boundaries, and structured reflection are not substitutes for agency; they are supports that make meaningful agency more achievable.

This is particularly important because teachers in the survey reported difficulties with group management, individual contribution, and students' self-directed learning. The design implication is that primary PjBL should provide choice within explicit boundaries and should preserve identifiable evidence of both group and individual participation.

6.3. Environmental action should be epistemically accountable to science learning

A central conceptual contribution of the framework is to treat environmental action not as a separate campaign after science learning, but as an application that should be justified by scientific evidence. Environmental education research cautions against assuming that knowledge automatically translates into ecological behavior (Otto & Pensini, 2017), while broader reviews emphasize outcomes extending beyond factual knowledge (Ardoin et al., 2018). The Curriculum–Inquiry–Action alignment proposed here addresses this tension by requiring students to explain how evidence informs a feasible response. Caring for a plant, conserving water, or improving a classroom environment becomes stronger evidence of learning when students can articulate the scientific reasoning that supports the action. The claim is therefore not that action alone demonstrates competence, but that scientifically justified action can provide contextualized evidence of application.

6.4. Assessment is infrastructure for coherent project learning

The assessment findings expose a method–assessment mismatch. Although teachers strongly endorsed awareness and behavior as environmental-education outcomes, reported assessment practices remained dominated by knowledge questions or tests, while process checklists, behavioral observation, and product rubrics were much less common. This matters because PjBL distributes learning across inquiry, collaboration, product development, explanation, and action. A single test or final artifact cannot make all of these dimensions visible. The proposed multi-source architecture therefore uses a small set of complementary tools, each tied to a distinct purpose. Importantly, "multi-source" does not mean maximizing the number of instruments; it means selecting the minimum evidence necessary to represent the learning dimensions that the project claims to develop.

6.5. Theoretical and practical contribution of the alignment framework

The framework extends a generic PjBL sequence by making three alignment relationships explicit. Curricular alignment protects disciplinary integrity; epistemic alignment protects the quality of inquiry and evidence; and action alignment protects environmental participation from becoming symbolic or disconnected from understanding. These relationships help explain why an activity can appear project-based yet remain educationally weak. The framework also translates survey-identified constraints into practical supports: a bounded five-stage cycle addresses procedural complexity and time; structured group roles address accountability; and low-burden multi-source assessment addresses the difficulty of evaluating both learning and contribution. The framework should therefore be understood as an evidence-informed design proposition to be tested, refined, and potentially adapted across contexts rather than as a validated universal model.

6.6. Implications for teacher education and professional development

For teacher education and professional development, the findings shift attention from awareness-raising toward instructional design competence. Support should include worked project exemplars linked to curriculum outcomes, practice in writing driving questions that require scientific evidence, strategies for structuring group accountability, and opportunities to design concise assessment tools before implementation. Teacher educators and school-based professional learning communities can also use the alignment questions—What science outcome is advanced? What evidence will students generate? How does the evidence justify action?—as a planning protocol for reviewing project quality. This orientation may be especially useful in settings where environmental education is already valued but sustained PjBL remains difficult to implement.

7. Limitations and Future Research

This study has several limitations. First, the convenience and purposive sample of 80 teachers from two northern Vietnamese provinces is context-specific and not nationally representative. Second, the survey was cross-sectional and self-reported, and responses concerning environmental education may be affected by social-desirability bias. Third, the analyses are descriptive and do not establish causal relationships between teacher beliefs, barriers, and practice. Fourth, the proposed framework was derived from literature, curriculum analysis, and teacher-reported needs but has not yet undergone classroom implementation or empirical validation. Fifth, the framework is anchored in one national curriculum context, and student, parent, and school-leader perspectives were not included in the present design process. Future research should therefore use classroom observation and implementation-fidelity evidence, examine the usability of the framework for teachers, include student learning and action outcomes, and conduct quasi-experimental or design-based studies that iteratively test and refine the framework across diverse school contexts.

8. Conclusion

Project-based environmental education in primary science can be strengthened when environmental activity is designed as part of disciplinary learning rather than as an additional campaign or product task. The present study documents a recognition–implementation gap among 80 Grade 4 Science teachers and translates the reported barriers, assessment practices, and support needs into an evidence-informed design response. The proposed Curriculum–Inquiry–Action Alignment Framework makes explicit three relationships: projects should advance identifiable science curriculum outcomes, engage students in evidence-producing inquiry, and connect environmental action to scientifically justified understanding. Five design principles, a five-stage instructional cycle, scaffolded collaboration, flexible learning ecologies, and multi-source assessment operationalize these relationships for primary classrooms. The framework is intended to help teachers address recurring design challenges involving time, group accountability, and assessment; its effectiveness should be established through future classroom implementation and empirical evaluation.

Conflict of Interest Statement

The authors declare no conflicts of interest.

About the Authors

Dr. Hang Nguyen Thi Thu is a lecturer at Thai Nguyen University of Education in Vietnam. She obtained her Ph.D. in Educational Theory and History from the Vietnam Institute of Educational Sciences in 2013. Dr. Hang is an author of textbooks for primary school students in Vietnam. Her primary research focuses on integrated teaching, STEM education for primary school students, and teacher training.

Nong Thi Hoi is a teacher at Phu Binh 2 Primary School, Thai Nguyen Province, Vietnam. Her professional interests include Grade 4 Science teaching and project-based environmental education.

References

Ardoin, N. M., & Bowers, A. W. (2020). Early childhood environmental education: A systematic review of the research literature. *Educational Research Review*, 31, 100353. https://doi.org/10.1016/j.edurev.2020.100353

Ardoin, N. M., Bowers, A. W., Roth, N. W., & Holthuis, N. (2018). Environmental education and K–12 student outcomes: A review and analysis of research. *The Journal of Environmental Education*, 49(1), 1–17. https://doi.org/10.1080/00958964.2017.1366155

Ferrero, M., Vadillo, M. A., & León, S. P. (2021). Is project-based learning effective among kindergarten and elementary students? A systematic review. *PLOS ONE*, 16(4), e0249627. https://doi.org/10.1371/journal.pone.0249627

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, 19(3), 267–277. https://doi.org/10.1177/1365480216659733

Krajcik, J. S., & Blumenfeld, P. C. (2006). Project-based learning. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 317–334). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526.018

Liefländer, A. K., Fröhlich, G., Bogner, F. X., & Schultz, P. W. (2013). Promoting connectedness with nature through environmental education. *Environmental Education Research*, 19(3), 370–384. https://doi.org/10.1080/13504622.2012.697545

Ministry of Education and Training. (2018). *General education curriculum: Science curriculum* (Issued with Circular No. 32/2018/TT-BGDĐT, December 26, 2018). Hanoi, Vietnam.

Nguyen, D. N., & Ngo, T. K. H. (2024). Applying project-based learning to educate primary school students on environmental protection. *HNUE Journal of Science: Educational Sciences*, 69(4), 97–108. https://doi.org/10.18173/2354-1075.2024-0067

Nguyen, M. G., & Le, M. N. (2024). A study of the current use of project-based learning in Grade 4 Science teaching at primary schools in Ho Chi Minh City. *Journal of Education, 24*(Special Issue 13), 180–184.

Nguyen, M. G., & Nguyen Ngoc Nhu, H. (2026). A study of the current integration of environmental protection education into project-based learning for Grade 4 students. *Dong Thap University Journal of Science*, Online First, 1–16. https://doi.org/10.52714/dthu.sch.3121.1942

Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change*, 47, 88–94. https://doi.org/10.1016/j.gloenvcha.2017.09.009

UNESCO. (2020). *Education for Sustainable Development: A Roadmap*. UNESCO. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000374802