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Research Article

Ecopedagogy for Equitable Green Skills Development in School Education: A Systematic Literature Review

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Abstract

Environmental disruption requires school education to develop green skills that combine ecological literacy, systems thinking, collaboration, and action. This systematic literature review synthesizes how ecopedagogic approaches support equitable green-skills development and identifies reporting gaps relevant to inclusive education and social welfare. Following a PRISMA 2020-aligned protocol, the review examined an author-supplied corpus of 100 records retrieved from Scopus and Google Scholar for 2021–2026. After duplicate removal, title–abstract screening, and full-text eligibility assessment, 15 studies were included. Thematic synthesis identified five recurring pathways: critical and relational inquiry, interdisciplinary curriculum integration, place-based and outdoor learning, action-oriented projects, and critically mediated digital learning. Reported outcomes clustered around ecological literacy, critical and systems thinking, participation, collaboration, and environmental responsibility. However, gender-disaggregated outcomes and intersectional access conditions were seldom reported, preventing a defensible synthesis of differential benefits for girls, women, or other marginalized groups. The review proposes an Equity-Responsive Ecopedagogic Pathway framework linking pedagogy, green-skill outcomes, and reporting requirements.

Keywords: Ecopedagogy; Ecological Literacy; Education For Sustainable Development; Equity; Green Skills.

INTRODUCTION

Climate instability, biodiversity loss, pollution, and unequal exposure to environmental risk intensify the educational responsibility to prepare learners for sustainable and socially just futures. Green education is increasingly framed as a cross-sector pathway through which learning systems can contribute to the Sustainable Development Goals, while environmental education research shows that durable outcomes extend beyond factual knowledge to include affective engagement, agency, and environmentally responsible behavior [1], [2], [3].

In this article, green skills are understood as environmentally relevant knowledge, dispositions, and capacities for action. This distinction is important because green skills and sustainability competences overlap but are not conceptually interchangeable: green skills are often associated with work, transitions, and applied environmental action, whereas sustainability competences are broader transversal capabilities for navigating complex socioecological problems [4], [5], [6].

Ecopedagogy offers a critical response to this challenge. Rather than treating environmental education as neutral transmission of conservation messages, it asks learners to examine the power relations, economic assumptions, cultural histories, and human–more-than-human relationships embedded in environmental problems [7], [8]. Contemporary scholarship presents ecopedagogy as transdisciplinary, relational, place-responsive, and action-oriented; it has been applied through interdisciplinary school work, outdoor and contemplative learning, and early-years pedagogies that resist extractive views of nature [9], [10], [11], [12]. Such approaches are relevant to education systems and social welfare because ecological disruption does not affect learners equally. Meaningful green-skills development therefore depends not only on instructional design but also on accessible participation, recognition of local knowledge, safe learning environments, and transparent reporting of who benefits.

The educational use of digital technology further sharpens this issue. Digital tools can widen access to environmental information, simulation, and collaboration, yet they can also reproduce techno-solutionism when ecological, ethical, and relational questions are displaced by the novelty of the tool [13], [14], [15], [16]. Existing reviews have mapped ecopedagogy, environmental literacy, and green skills mainly as separate domains. Less attention has been given to the pedagogical mechanisms that connect them and to whether studies report equity-relevant conditions and outcomes. This gap matters for scholarship on education, inclusion, and social welfare: without disaggregated evidence, claims about who benefits from sustainability learning remain provisional.

Accordingly, this review synthesizes the author-supplied corpus to answer three questions: (RQ1) Which ecopedagogic approaches are represented in the selected literature? (RQ2) Which green-skills outcomes are associated with those approaches? and (RQ3) How do the studies report equity-relevant conditions, including gender, participation, and access? The article contributes an Equity-Responsive Ecopedagogic Pathway framework that specifies links among pedagogical design, green-skills outcomes, and equity reporting. This contribution addresses calls for environmentally transformative education that remains critical of both superficial sustainability claims and decontextualized competence frameworks [17], [18], [19], [20], [21], [22], [23].

METHODS

Research Design

This study used a qualitative systematic literature review with thematic synthesis. The review followed the reporting logic of PRISMA 2020, including transparent accounting of records across identification, screening, eligibility assessment, and inclusion [24], [25]. The purpose was not to estimate a pooled effect size; rather, it was to identify recurring pedagogical pathways, green-skills outcomes, and equity-reporting practices across a heterogeneous body of empirical and conceptual work.

Participants and Sampling

The unit of analysis was the published study, not individual human participants. The review retained 15 studies from an author-supplied initial corpus of 100 records obtained from Scopus (n = 50) and Google Scholar (n = 50) and dated 2021–2026. Inclusion criteria were: (a) explicit engagement with ecopedagogy, environmental education, ecological literacy, or green skills; (b) relevance to school-age learning, teacher education, or educational design with direct implications for school education; (c) full-text availability; and (d) English- or Indonesian-language publication. Duplicate records, studies lacking a meaningful connection to the review concepts, and studies without a school-education implication were excluded. Search reporting was structured according to PRISMA-S to preserve reproducibility of the documented search and screening process [26].

Operational Definitions of Variables

Because this is a systematic review, the term variables denotes analytic constructs rather than statistically manipulated variables. Table 1 operationalizes the codes used during extraction and synthesis.

Table 1. Operational Definitions and Analytic Coding Framework

Analytic Construct	Operational Definition	Core Coding Indicators	Equity And Welfare Lens
Ecopedagogic integration	A critical, relational, and action-oriented educational approach linking ecological issues with social, cultural, and economic relations.	Critical inquiry; place relations; local knowledge; learner voice; action orientation.	Whose knowledge is recognized; whose participation is enabled; how structural constraints are acknowledged.
Green skills	Applied environmental knowledge, dispositions, and capacities that support sustainable decision-making and action.	Ecological literacy; systems/critical thinking; collaboration; problem-solving; environmental responsibility.	Whether outcomes are reported by gender, social position, disability, locality, or resource access.

Analytic Construct	Operational Definition	Core Coding Indicators	Equity And Welfare Lens
Equity-responsive reporting	Explicit documentation of access conditions, participation patterns, and outcome differences relevant to inclusion and social welfare.	Gender-disaggregated data; participant context; access supports; local/community involvement; safeguarding.	Avoids universal claims when differential benefit has not been demonstrated.
School-education relevance	Direct application to school learners, teachers, curriculum, or learning design transferable to primary and secondary schooling.	School setting; teacher education; curriculum implementation; pedagogic model.	Feasibility for diverse school and community contexts.

Hypotheses Development

Systematic reviews of heterogeneous studies do not test participant-level causal hypotheses. To retain analytical discipline, the study specified two a priori propositions: P1—ecopedagogic integration is most plausibly associated with green-skills development when learning is critical, experiential, relational, and action-oriented; and P2—the strength and transferability of reported outcomes depend on whether studies describe equity-relevant access conditions and disaggregated participation or outcome data. These propositions guided the extraction matrix and interpretation rather than serving as statistical hypotheses.

Data Collection Procedure

The research team reviewed the search and screening totals supplied in the original manuscript. Following duplicate removal, titles and abstracts were assessed against the inclusion criteria; potentially eligible texts were examined in full. The included evidence was then extracted into a structured matrix containing publication metadata, educational setting, pedagogical approach, targeted outcomes, key findings, and equity-relevant reporting. This approach follows structured-review guidance that recommends explicit protocol decisions, transparent extraction, and a clear connection between review questions and synthesis [27], [28].

Data Analysis

A directed thematic synthesis was performed. First-cycle codes reflected the operational definitions in Table 1. Second-cycle coding grouped these codes into pedagogical pathways and outcome domains. The review then compared the evidentiary basis for each pathway, distinguishing direct school-based evidence from conceptual or adjacent educational evidence. The analysis also logged absent or limited reporting, because missing gender, socioeconomic, or accessibility information constrains the social interpretation of claims about sustainability learning. A flow-based, decision-traceable review process was used rather than bibliometric counting because the corpus was small and substantively heterogeneous [29].

Validity and Reliability

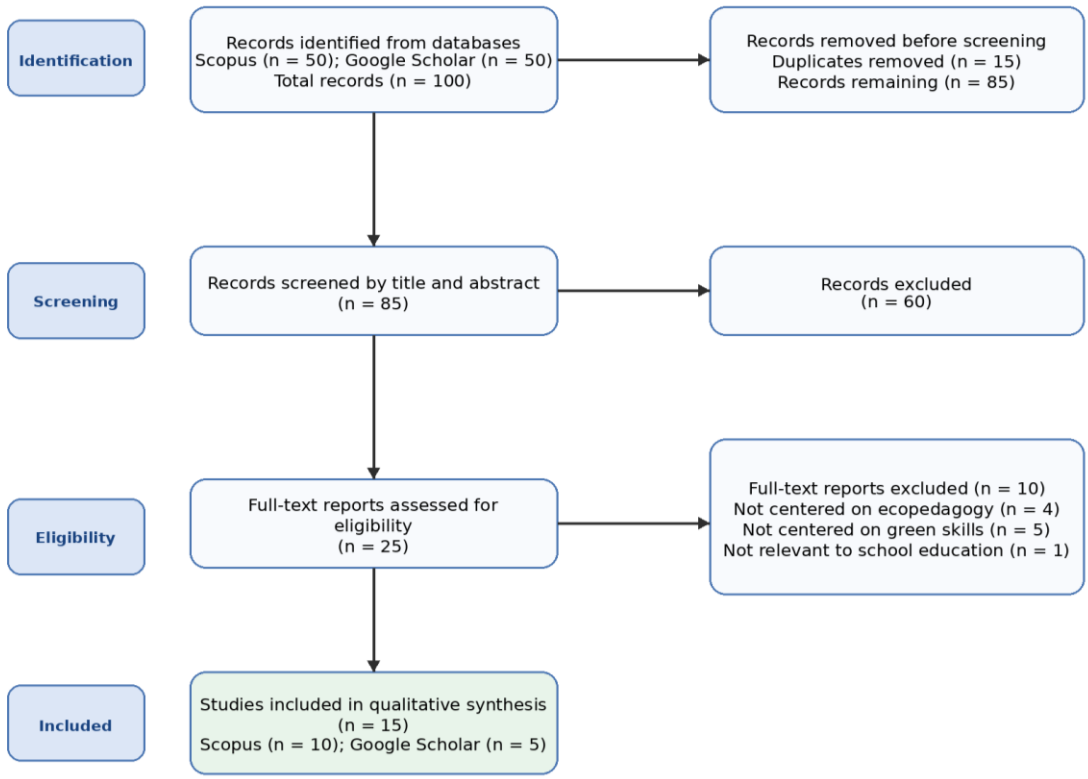
Validity was supported through a priori inclusion criteria, a transparent screening trail, conceptually defined codes, and direct linkage between research questions, extracted evidence, and synthesis claims. Reliability was strengthened by using a structured extraction matrix and retaining only claims that could be traced to included studies. The results should nevertheless be read as an interpretive synthesis rather than a meta-analysis: methodological diversity, uneven outcome measurement, and limited equity reporting preclude comparative effect estimates. Ethical approval was not required because the review analyzed published material and did not involve new data collection from human participants.

RESULTS AND DISCUSSION

Results

Study Selection and Evidence Profile

The selection process is presented in Figure 1. From 100 records, 15 duplicates were removed. The remaining 85 records were screened by title and abstract, resulting in the exclusion of 60 records. Twenty-five full texts were assessed, and 10 were excluded because they did not meaningfully address ecopedagogy (n = 4), green skills or a closely related outcome (n = 5), or school-education relevance (n = 1). Fifteen studies were retained for qualitative synthesis.



Source: Author-supplied search log and screening totals from the original manuscript; diagram redrawn following the PRISMA 2020 flow structure.

Figure 1. PRISMA 2020–Aligned Flow Diagram of Study Identification, Screening, and Inclusion

The included corpus combined reviews, conceptual analyses, qualitative studies, and applied education studies. Consequently, the evidence supports a map of plausible pedagogical mechanisms and reported outcome patterns, not a comparative causal ranking of interventions. Table 2 records the screening decisions, while Table 3 summarizes the evidence profile.

Table 2. Study Selection and Screening Decisions

Review Stage	Decision Rule	Records (N)	Interpretive Note
Identification	Records listed in author-supplied search log	100	Scopus: 50; Google Scholar: 50.
Pre-screening	Duplicate records removed	15	One record retained per study.
Title–abstract screening	Records assessed	85	Relevance to ecopedagogy, green skills, or closely related school education outcomes.
Title–abstract screening	Records excluded	60	Insufficient conceptual or contextual fit.
Eligibility	Full texts assessed	25	Full-text assessment against inclusion criteria.
Eligibility	Full texts excluded	10	Ecopedagogy absent: 4; green-skills link absent: 5; school relevance absent: 1.
Inclusion	Studies synthesized	15	Ten records sourced from Scopus and five from Google Scholar.

Table 3. Characteristics of the Included Evidence Base (n = 15)

Study Cluster	Educational Focus	Principal Contribution To Synthesis	Evidence Boundary
Green education and competence reviews [1], [4]	Education for sustainable development; conceptual mapping	Clarify the scope of green skills and sustainability competences.	Review-level evidence; no common outcome metric.
Vocational and teacher education [5], [6], [30]	Vocational education; STEM teacher preparation	Show the importance of educator capability and applied sustainability learning.	Settings are not directly equivalent to primary schooling.
Critical ecopedagogy [7], [8], [21], [23]	Ecopedagogy; environmental education; critical sustainability education	Explain why environmental learning must address power, values, and sociopolitical contexts.	Predominantly conceptual or qualitative evidence.
Transdisciplinary and	School-age learning;	Demonstrate links among curriculum integration,	Outcome measures are not standardized.

Study Cluster	Educational Focus	Principal Contribution To Synthesis	Evidence Boundary
interdisciplinary learning [9], [10]	interdisciplinary curriculum	broad learning, and ecological inquiry.	
Outdoor, relational, and early-years learning [11], [12], [18], [19], [31], [32]	Outdoor education; nature connection; early childhood	Indicate the role of place, emotion, reflection, and relational practice.	Often small-scale or context-specific.
Digital and postdigital education [13], [14], [15], [16]	Educational technology; digital environmental learning	Identify both affordances and risks of digitally mediated sustainability education.	Technology is not itself an ecopedagogic mechanism.

Pathways of Ecopedagogic Integration

Five recurrent pathways emerged. First, critical and relational inquiry invites learners to interrogate the social and political conditions of environmental harm and to consider responsibilities across human and more-than-human relations. Second, interdisciplinary curriculum integration connects environmental questions with science, social studies, language, arts, and civic learning. Third, place-based and outdoor learning uses direct encounters, reflection, and locally meaningful sites to support affective and cognitive engagement. Fourth, action-oriented projects move learners from diagnosis to collaborative response. Fifth, critically mediated digital learning uses technologies as objects of inquiry and support for participation rather than as automatic solutions. Table 4 translates these pathways into a synthesis matrix.

Table 4. Ecopedagogic Pathways, Reported Green-Skills Outcomes, and Implementation Implications

Pathway	Illustrative Evidence	Reported Outcome Domains	Implication For School Education
Critical and relational inquiry	Critical ecopedagogy, decolonial and rights-oriented analyses [7], [8], [21], [22], [23]	Critical thinking; ethical reasoning; systems awareness; environmental responsibility.	Embed questions of power, equity, consumption, and local ecological histories in learning tasks.
Interdisciplinary curriculum integration	Transdisciplinary and interdisciplinary school work [9], [10]	Ecological literacy; creativity; integration of knowledge; communication.	Organize environmental problems as cross-curricular inquiries rather than isolated topics.
Place-based and outdoor learning	Nature reflection, outdoor pedagogy, riverine and relational learning [11], [12], [18], [19], [31], [32]	Nature connection; reflection; wellbeing; observation; ecological empathy.	Use safe, accessible local sites and structured reflection before, during, and after field-based learning.
Action-oriented projects	Green education, vocational green skills,	Problem-solving; collaboration;	Link investigation to feasible

Pathway	Illustrative Evidence	Reported Outcome Domains	Implication For School Education
	and teacher preparation [1], [5], [6], [30]	initiative; applied environmental action.	school/community projects and public communication.
Critically mediated digital learning	Digital environmental education and postdigital capability work [13], [14], [15], [16]	Digital literacy; critical evaluation; collaboration; informed use of data.	Treat digital tools as means for inquiry, representation, and participation; discuss their ecological and social costs.

Green-Skills Outcomes and Equity Reporting

Across the corpus, ecological literacy, critical or systems thinking, collaboration, communication, problem-solving, environmental responsibility, and reflective agency were the most consistently reported outcomes. These outcomes align with the literature's view that sustainability learning is multidimensional and cannot be reduced to environmental knowledge alone [4], [33]. However, the synthesis found a major evidentiary limitation: few studies reported gender-disaggregated outcomes, socioeconomic conditions, disability-related access, rural–urban differences, or the distribution of learner voice. Several studies explicitly valued local knowledge, participation, or relational ethics, but these commitments were not consistently translated into transparent outcome reporting. Therefore, the review does not infer that benefits were equal across girls, boys, women, men, or differently positioned learner groups.

Table 5. Equity-Responsive Ecopedagogic Pathway Framework

Design Anchor	Synthesis Implication	Minimum Evidence To Report	Policy And Practice Relevance
Access	Green-skills opportunities are shaped by time, place, resources, safety, and technological availability.	Setting, participant characteristics, accessibility supports, and participation constraints.	Direct investment toward schools and communities with unequal environmental and educational resources.
Recognition	Ecopedagogy is strongest when local ecological knowledge and learner experience are treated as legitimate knowledge.	Whose knowledge informed learning design; community involvement; language and cultural context.	Avoid one-size-fits-all sustainability content and strengthen locally grounded curriculum design.
Participation	Action-oriented learning should enable meaningful learner voice rather than only compliance	Roles in inquiry, decision-making, collaboration, and public communication.	Support inclusive participation, including safe roles for learners who may be marginalized.

Design Anchor	Synthesis Implication	Minimum Evidence To Report	Policy And Practice Relevance
	with teacher-directed tasks.		
Outcome distribution	Average gains do not establish equitable benefits.	Gender- and context-disaggregated outcomes where appropriate; explanation of missing data.	Enable welfare and education actors to identify who benefits, who is excluded, and why.
Transfer and accountability	Sustainability learning should be connected to feasible school and community action.	Evidence of application, reflection, and sustainability of action beyond a single activity.	Link curriculum, teacher development, community partnerships, and school welfare initiatives.

Summary of Analytical Propositions

P1 was supported at the level of thematic convergence: the corpus repeatedly connected green-skills development with critical, experiential, relational, and action-oriented learning, rather than with information delivery alone. P2 was also supported: the limited reporting of participant conditions and disaggregated outcomes reduced confidence in universal claims about benefit. This finding does not demonstrate inequity; it demonstrates that the available evidence is insufficient to evaluate equity rigorously.

Discussion

This review indicates that ecopedagogy can be positioned as a pedagogical infrastructure for equitable green-skills development, rather than as a supplementary environmental theme. The synthesis confirms that ecological literacy becomes more educationally consequential when learners are invited to connect environmental conditions with social relationships, local places, power, and action. This interpretation is consistent with research that distinguishes broad sustainability competences from narrower green-skills agendas and that calls for educational approaches capable of navigating complexity, community engagement, and context [4], [33]. It also helps explain why interdisciplinary, place-based, and project-oriented practices recur across the evidence: each creates opportunities for learners to interpret environmental problems as lived and relational, not merely technical.

The review extends the existing literature in two ways. First, it integrates ecopedagogy, green skills, and equity reporting within one analytic frame. Previous studies have frequently considered ecological awareness, competence development, or environmental pedagogy separately. The Equity-Responsive Ecopedagogic Pathway framework identifies four conditions that should be visible in research and practice: access, recognition, participation, and outcome distribution. This is the study's central novelty. It shifts the question from whether a sustainability activity is engaging to whether its conditions and benefits are sufficiently documented to support defensible claims about inclusion. The framework is especially relevant to journals concerned with education and social welfare because it connects classroom design to participation, community recognition, and the uneven distribution of opportunities.

Second, the findings challenge a technology-centered account of environmental education. The reviewed literature indicates that digital resources can support data inquiry, collaboration, and representation, but they do not substitute for critical environmental learning. Technology should therefore be selected through a postdigital lens that considers its ecological footprint, access requirements, and influence on learner agency [13], [14], [15], [16]. In practice, teachers can combine locally grounded observation with selective digital documentation, mapping, or storytelling. This approach preserves the relational and experiential character of ecopedagogy while enabling learners to communicate evidence and collaborate beyond the classroom.

The implications are both practical and policy-oriented. At the classroom level, teachers should formulate environmental units around locally situated questions, integrate multiple disciplines, use reflection to connect feeling and evidence, and culminate in feasible collective action. At the school-system level, curriculum leaders should build teacher capacity for critical sustainability education, resource equitable outdoor and digital participation, and establish partnerships with families and local communities. At the policy level, sustainability programs should report not only implementation activities but also participation conditions and differential outcomes. Recent work on teacher preparation, environmental education, and sustainable higher education similarly emphasizes that institutional capacity and inclusive learning design are necessary for sustainability commitments to become educational practice [30], [34], [35].

The discussion must be read with appropriate caution. The review evidence is heterogeneous and includes conceptual, qualitative, and review studies alongside applied educational work. The small corpus and author-supplied search log restrict the comprehensiveness of the review. Moreover, absence of demographic reporting is not evidence of absence of inclusive practice; it is an evidentiary gap that warrants better study design and reporting. Future research should develop validated school-level green-skills measures, examine the framework in diverse settings, report ethically appropriate disaggregated outcomes, and use mixed-methods designs to explain how learners' ecological agency emerges across gendered, geographic, socioeconomic, and disability-related contexts.

CONCLUSION

This systematic literature review shows that ecopedagogy can support green-skills development when sustainability learning is critical, interdisciplinary, place-responsive, reflective, and action-oriented. The evidence does not justify a single best method; instead, it identifies complementary pathways that connect ecological literacy, systems and critical thinking, collaboration, responsible action, and learner agency. The study's contribution is the Equity-Responsive Ecopedagogic Pathway framework, which makes access, recognition, participation, and outcome distribution visible as conditions for responsible claims about educational benefit. For school education, the priority is therefore not merely to add environmental content, but to design learning experiences that are locally meaningful, socially inclusive, and accountable for who can participate and who benefits.

LIMITATIONS

The review is limited by its small, heterogeneous corpus of 15 studies, an author-supplied search log, the inclusion of only Scopus and Google Scholar records, and the 2021–2026 publication window. These features limit both comprehensiveness and generalizability. The synthesis did not conduct meta-analysis because outcomes, settings, and study designs were not sufficiently comparable. In addition, several studies offered limited demographic or access reporting, which constrained the review's ability to examine differential benefits across gender and other social positions. Future reviews should preregister a protocol, search additional databases, use independent dual screening, incorporate citation chasing, and apply mixed-methods or meta-analytic techniques where comparable outcome measures become available.

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AUTHOR CONTRIBUTION

F.S. conceptualized the study, developed the review protocol, coordinated screening and data extraction, conducted the synthesis, and drafted the manuscript. Y.T.H. contributed to the theoretical framing, reviewed the analytic categories, and critically revised the manuscript. Y.Y. contributed to evidence extraction, interpretation, and manuscript revision. All authors approved the final manuscript and accept responsibility for the integrity of the work.

CONFLICT OF INTEREST

"The authors declare no conflict of interest."

DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

The authors used ChatGPT to support language refinement and manuscript organization during preparation of this work. The authors reviewed, edited, and verified all AI-assisted text and remain fully responsible for the accuracy, interpretation, and integrity of the final manuscript.

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