

Systematic Review

Systematic Review of Environmental Education in Morocco: Policies, Practices, and Post-Pandemic Challenges in the Context of the Sustainable Development Goals

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Abstract

Environmental education (EE) is central to achieving the Sustainable Development Goals (SDGs), particularly where inequalities constrain access to quality learning. Following PRISMA 2020, this review synthesizes 35 peer-reviewed studies and policy documents to examine Morocco's EE policies and practices against global frameworks and post-pandemic challenges. A systematic search was conducted in Scopus, Web of Science, ERIC, ProQuest/EBSCO, Google Scholar, and national repositories (January 2000–December 2024; executed 15–17 March 2024). Findings show strong discursive alignment with SDG 4.7 and UNESCO's ESD 2030 Roadmap but persistent implementation gaps: rural and peri-urban schools face resource shortages; teacher preparation for participatory, interdisciplinary approaches remains limited; and environmental clubs often rely on short-term projects without stable institutional support. The COVID-19 period exacerbated these pressures yet opened opportunities to integrate health–environment linkages, digital tools, and adaptive pedagogy. Equity reporting was limited (31% gender; 37% residence; 9% socio-economic status). Arabic-only records were identified ($n = 42$) and title/abstract-screened ($n = 17$) but excluded due to translation constraints (language bias). To advance transformative EE, we recommend prioritizing participatory, place-based teacher education; institutionalizing school clubs with light monitoring and baseline grants; targeting support to reduce territorial inequities; and developing an SDG-aligned national dashboard. Expanding longitudinal, quasi-experimental, and participatory designs is critical to strengthen causal claims and inform policy.

Keywords: environmental education; Morocco; SDG 4.7; ESD 2030; PRISMA; rural–urban disparities; teacher professional development; environmental clubs; One Health; post-COVID



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1. Introduction

Over the past two decades, environmental education (EE) has emerged as a critical pillar in the global response to escalating ecological crises—ranging from climate change and biodiversity loss to pollution and unsustainable resource use [1,2]. Framed within Education for Sustainable Development (ESD), EE seeks not only to transmit environmental knowledge, but also to foster the values, skills, and transformative agency required for sustainable societal transitions [3,4]. The United Nations Sustainable Development Goals (SDGs), and particularly target 4.7, underscore the need for inclusive and

context-sensitive EE that promotes critical thinking, civic engagement, and the adoption of sustainable lifestyles.

While the global discourse emphasizes universal principles of sustainability, there is growing recognition that EE must be locally contextualized to address the socio-economic realities, governance structures, and cultural frameworks of specific countries. This challenge is particularly acute in Global South contexts, where structural inequalities, fragmented policy implementation, and limited educational resources can undermine transformative impact [5–7].

In Morocco, EE is embedded within national sustainability strategies, most notably the National Sustainable Development Strategy (NSDS, 2017) [8]. Initiatives such as the Eco-Schools programme, led by the Mohammed VI Foundation for Environmental Protection in collaboration with UNESCO and the Foundation for Environmental Education (FEE), have reached millions of students across thousands of schools, engaging them in hands-on projects on water conservation, waste reduction, and biodiversity protection [9]. Educational reforms have also integrated environmental content into formal curricula, including English as a Foreign Language (EFL) material. However, research shows that such integration often remains superficial, with limited contextual adaptation [10].

Despite these advances, systemic barriers persist. Uneven resource distribution, insufficient teacher training, and weak inter-institutional coordination limit the scalability and equity of EE programmes [11–13]. These challenges are especially pronounced in rural areas, where infrastructural deficits hinder access to quality EE and exacerbate territorial disparities.

The COVID-19 pandemic acted as both a stress test and a catalyst for change in Morocco's EE landscape. Nationwide school closures and the rapid shift to remote learning exposed stark digital divides, disproportionately affecting rural and marginalized communities [14–16]. At the same time, the crisis amplified awareness of health–environment interlinkages, particularly regarding the safe management of medical waste from vaccination campaigns [17]. Conversely, the pandemic also stimulated innovation—prompting the adoption of hybrid learning, digital tools, and integrated health–environment teaching approaches [18–20].

1.1. Originality and Added Value of This Study

Although several previous studies have examined specific aspects of environmental education (EE) in Morocco—such as school-based environmental clubs, curricular integration, or one-off programme evaluations—none, to our knowledge, has combined a critical integrative review with the PRISMA 2020 protocol to provide a systemic vision that encompasses political, pedagogical, and institutional dimensions while integrating the post-pandemic perspective. This dual articulation—methodological rigour derived from a systematic review and a context-sensitive reading of Morocco's socio-territorial realities—distinguishes the present study from existing reviews, including those conducted in other Global South countries.

Furthermore, this review adds comparative value by juxtaposing the Moroccan case with experiences from Africa, Asia, and Latin America, allowing the identification of transferable levers as well as Morocco-specific structural constraints.

1.2. Expected Operationalisation of the Findings

The conclusions of this review go beyond an academic diagnosis to propose concrete strategic directions that can be directly integrated into Moroccan educational policies:

- Reform of initial and in-service teacher training, embedding mandatory modules on participatory, place-based, and interdisciplinary EE approaches.

- Institutionalisation of environmental clubs through baseline funding, shared governance, and simplified monitoring and evaluation mechanisms.
- Reduction in territorial inequalities via “equity packages” (educational kits, connectivity, coaching) targeted at rural and peri-urban areas.
- Creation of a national EE indicator dashboard aligned with SDG 4.7 to guide funding allocations and strengthen accountability.

These directions, derived from the critical synthesis of 35 high-quality sources, provide policymakers, practitioners, and donors with an immediately actionable framework capable of accelerating the anchoring of an inclusive, resilient, and internationally aligned environmental education system.

This dual reality—persistent systemic limitations coupled with emerging opportunities—raises a critical research question:

To what extent can Morocco’s environmental education framework, as currently designed and implemented, meet the requirements of SDG 4.7 while integrating the lessons learned from the COVID-19 crisis to strengthen equity, resilience, and transformative capacity?

2. Literature Review

2.1. Global Frameworks and Trends in Environmental Education

Internationally, environmental education (EE) has evolved from a knowledge-transmission model to a transformative, action-oriented approach aimed at fostering systemic thinking, civic engagement, and sustainable lifestyles [1,2]. Policies such as UNESCO’s ESD 2030 Roadmap and SDG target 4.7 advocate for locally contextualized, equity-driven EE that addresses both environmental and social justice dimensions. Comparative studies from the Global South (e.g., Kenya, Brazil, India) reveal recurring structural barriers—notably resource inequities, insufficient teacher training in participatory and place-based pedagogies, and fragmented governance structures—that limit the operationalization of global goals at national and local levels [4,21]. These patterns provide a broader systemic lens for situating the Moroccan case, highlighting the need for both global alignment and contextual adaptation.

2.2. The Moroccan Policy Landscape

Morocco has formalized its EE commitment through the National Sustainable Development Strategy [8] and collaborative initiatives such as the Eco-Schools program [9]. While these frameworks provide policy legitimacy, international recognition, and a formal anchor to global sustainability agendas, empirical studies have found that their translation into school-level practice remains partial. Evidence points to persistent disparities between urban, peri-urban, and rural contexts; uneven teacher preparation in participatory and interdisciplinary approaches; and a dependence on short-term, project-based funding with limited sustainability and monitoring [11,13,22]. This section builds directly on prior empirical research rather than solely summarizing policy texts, thereby clarifying the operational gap between strategic commitments and on-the-ground implementation.

In the Moroccan context, evidence also points to conceptual gaps in biodiversity education that translate into limited classroom practice. A mixed-methods study conducted in Guelmim (rural and urban high schools) documented incomplete teacher conceptions of biodiversity and weakly structured pedagogical activities, underscoring the need for clearer curricular conceptualization and contextualized field-based tasks (e.g., local inventories, seasonal monitoring, citizen-science projects) to strengthen learning and transfer into action [23]. This aligns with our diagnosis of an implementation gap between policy commitments and school-level practices and supports recommendations for targeted teacher professional development and place-based project work in biodiversity education [23].

2.3. COVID-19 as a Disruptive and Catalytic Force

The COVID-19 pandemic acted as both a stress test and a catalyst for innovation in EE. Internationally, remote learning revealed deep digital divides but also stimulated hybrid pedagogies, cross-disciplinary health–environment content, and community-based initiatives [17,18]. Moroccan studies report similar disruptions: school closures severely constrained EE continuity, particularly in underserved areas, while simultaneously creating opportunities to integrate public health themes, digital tools, and participatory environmental action at local levels [24,25]. This perspective extends prior scholarship by framing the pandemic not only as a challenge but also as an entry point for systemic resilience and innovation in Moroccan EE.

2.4. Research Gaps and Added Value of the Present Study

Despite the policy momentum and pandemic-driven adaptations, research on Moroccan EE remains fragmented and predominantly descriptive, with few studies adopting longitudinal or mixed-methods designs capable of capturing sustained behavioral and attitudinal change among learners. Beyond the Moroccan corpus included in this review, a recent bibliometric mapping highlights the underrepresentation of Morocco within global EE scholarship and the fragmentation of research strands, reinforcing the need for cumulative, context-sensitive evidence [26]. Equity dimensions—such as gender, socioeconomic background, and geographic location—are rarely disaggregated in reporting. Moreover, there is limited integration of health–environment synergies into EE practice, and few analyses bridge policy frameworks, pedagogical practices, and institutional governance in a unified framework.

This review addresses these gaps through a PRISMA-guided critical synthesis of 35 peer-reviewed studies and policy documents, offering a dual contribution:

- Mapping Morocco’s EE alignment with SDG 4.7 and the UNESCO ESD 2030 Roadmap, situating it within a comparative Global South perspective (Africa, Asia, Latin America).
- Proposing actionable reforms that are directly operationalizable in Moroccan educational policy and practice, including teacher training reform, institutionalization of school environmental clubs, targeted equity packages for underserved areas, and the creation of a national EE monitoring dashboard.

By articulating methodological rigor with contextual relevance, this study positions itself as both a scholarly contribution and a practical roadmap for accelerating the adoption of inclusive, resilient, and internationally aligned EE in Morocco.

3. Materials and Methods

This critical integrative review investigates how environmental education (EE) policies, programs, and pedagogical practices in Morocco align with international sustainability frameworks, while considering local socio-territorial realities and post-pandemic challenges. The reporting structure follows PRISMA 2020 guidelines [27] to ensure methodological transparency and reproducibility. The analysis is framed by the Sustainable Development Goals (SDGs)—particularly SDG 4.7 on inclusive and transformative education—and the UNESCO ESD 2030 Roadmap [1].

Three research questions guided the review:

- a. To what extent do Moroccan EE policies and practices align with global frameworks and post-pandemic priorities?
- b. What structural and institutional barriers (e.g., territorial inequalities, teacher capacity gaps, fragmented governance) limit equitable and context-sensitive EE?

- c. Which strategies—especially participatory, place-based, and justice-oriented approaches—can enhance EE’s transformative potential in Morocco?

3.1. Review Design and Rationale

An integrative review approach [28] was adopted to synthesize empirical studies, policy documents, and theoretical contributions, enabling a multi-dimensional understanding of the Moroccan EE landscape. The use of PRISMA 2020 [27] provided a structured audit trail from study identification to synthesis. A pre-defined protocol—including eligibility criteria, search strategies, and screening procedures—was developed before data collection (available upon request). To strengthen transparency, explicit reporting of quality score distributions by study type and criteria was planned [29]. The protocol was registered on the Open Science Framework (OSF) for traceability.

3.2. Search Strategy and Information Sources

A systematic search was conducted across seven major databases: Scopus, Web of Science Core Collection, ERIC, ProQuest Education Database, Education Source (EBSCO), ScienceDirect, and SpringerLink. To ensure broader coverage, additional searches were carried out in Google Scholar and national repositories, including the Ministry of National Education and the Mohammed VI Foundation for Environmental Protection [22].

The search period extended from January 2000 to December 2024, with the last update performed on 31 December 2024. The year 2000 was chosen as the starting point since it coincides with the launch of Morocco’s National Charter for Education and Training and the first environmental education initiatives aligned with Agenda 21.

Search strategies combined thematic keywords with Boolean operators (e.g., “environmental education” AND Morocco/Maroc, “education for sustainable development”, “post-pandemic” AND youth AND environmental behavior). Exact database-specific queries (including field tags, date ranges, and applied filters), along with execution dates and retrieval counts, are reported in Supplementary Materials, Table S1.

Both English and French sources were considered. Arabic-only publications were excluded due to translation constraints; however, abstracts were screened whenever available to partially mitigate the language bias. The number of Arabic records initially detected and screened is reported in the Risk of Bias section, together with a discussion of its implications.

The overall process of study identification, screening, and inclusion is summarized in the PRISMA 2020 flow diagram (Figure 1), which has been relocated here for clarity.

3.3. Eligibility Criteria

The eligibility criteria were defined a priori as follows:

Inclusion criteria

- Peer-reviewed journal articles or official policy documents explicitly addressing environmental education (EE) or education for sustainable development (ESD) in terms of theory, policy, or practice.
- Studies with a direct empirical or conceptual focus on Morocco, or comparative studies in which Morocco was included as a case context.
- Publications with a clear methodological framing, whether empirical (quantitative, qualitative, or mixed-methods), policy-oriented, or conceptual/analytical.

Exclusion criteria

- Non-refereed grey literature (e.g., blogs, conference abstracts not peer-reviewed, opinion pieces).
- Studies with insufficient methodological transparency or lacking analytical depth (e.g., purely descriptive reports without data or theoretical grounding).

- Publications outside the thematic scope of EE/ESD in the Moroccan context.
- Theses/dissertations not formally peer-reviewed or not published in an academic journal or recognized institutional series.

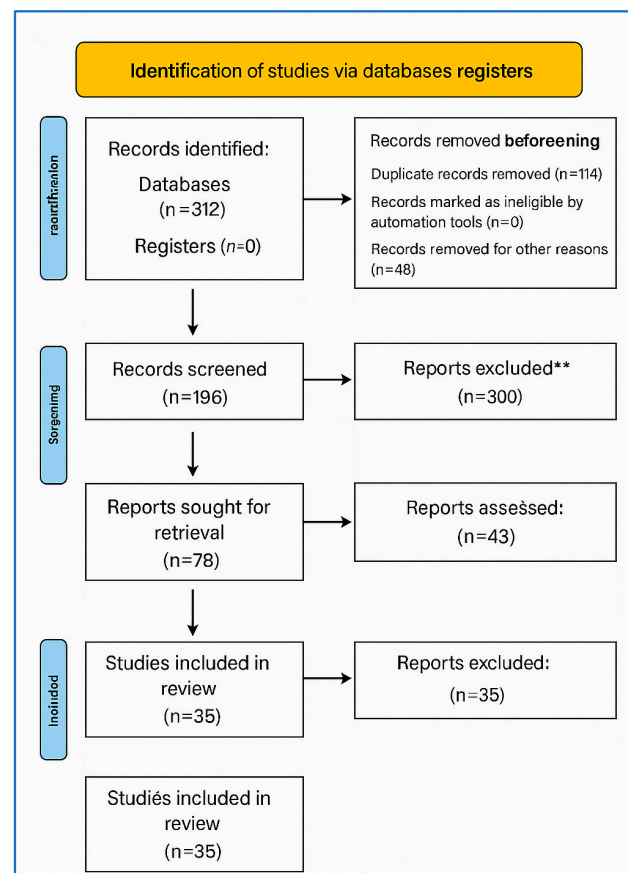


Figure 1. PRISMA flow diagram summarizing the study selection process. Note: The asterisks (**) indicate specific inclusion and exclusion criteria applied during the screening process.

All retrieved records were exported into a reference manager and duplicates were removed. The screening process was conducted in two phases: (i) title and abstract screening, and (ii) full-text eligibility assessment. Two independent reviewers screened all records in parallel. Cohen's kappa was calculated at the abstract screening stage to assess inter-rater reliability ($\kappa = 0.82$; 95% CI [0.76–0.88]), indicating substantial agreement. Disagreements were resolved through discussion until consensus was reached; although a third reviewer was available, arbitration was not required.

Arabic-language publications were excluded at the full-text stage due to translation constraints. However, abstracts were systematically screened whenever available. In total, 42 Arabic records were initially identified across databases, of which 17 abstracts were screened; none met the eligibility criteria for full inclusion. This exclusion introduces a potential language bias, which is further discussed in the Limitations section.

Mixed-methods studies were adjudicated by consensus: if at least one component fulfilled the eligibility criteria, the study was retained and coded accordingly. Quality appraisal was performed for all included studies using standardized criteria (see Table 1). Quality ratings were primarily descriptive and did not lead to exclusion; however, a sensitivity analysis was conducted to test whether excluding low-quality studies would alter the observed patterns, and no substantial differences were found.

Table 1. Quality assessment summary.

Study Type	High Quality	Acceptable Quality	Low Quality	Total
Quantitative/Mixed-methods	8	13	2	23
Qualitative	1	9	0	10
Policy/Official documents	0	2	0	2
Total	9	24	2	35

Notes: MMAT = Mixed Methods Appraisal Tool; CASP = Critical Appraisal Skills Programme; AACODS = Authority, Accuracy, Coverage, Objectivity, Date, Significance.

Search strategies were adapted to each database, with specific field tags, date ranges, and filters. For instance, in Scopus, the query used TITLE-ABS-KEY, whereas in ERIC, controlled vocabulary descriptors were employed. Detailed search strings, execution dates, and retrieval counts are reported in Supplementary Table S1. In the main text, it should be noted that Scopus and Web of Science captured a broader set of peer-reviewed journal articles, while ProQuest and EBSCO Education Source contributed additional dissertations and reports.

3.4. Study Selection and Inter-Rater Agreement

Search results were imported into Zotero v6.0.26 for de-duplication (algorithmic + manual verification). Two reviewers (R1 and R2) independently screened titles/abstracts and then assessed full texts using Rayyan QCRI (web-based version, accessed April 2025) [30]. Discrepancies were resolved through discussion or arbitration by a third reviewer (R3).

At the full-text screening stage, 43 records were excluded for reasons including:

- Lack of focus on Morocco (n = 15)
- Absence of methodological transparency (n = 12)
- Insufficient analytical depth (n = 9)
- Not within EE/ESD scope (n = 7)

The PRISMA flow diagram summarizes the process: 312 records identified → 198 after de-duplication → 78 full texts assessed → 35 studies included.

Inter-rater reliability was measured using Cohen's kappa (κ) [31] at each phase; values ranged between 0.74 and 0.82, indicating substantial agreement.

3.5. Data Extraction

A standardized form was used to capture:

- Authorship, year, setting, design, and sample.
- Methodological approach (quantitative, qualitative, or mixed).
- Thematic focus (policy, pedagogy, institutional barriers, COVID-19).
- Links to SDGs (esp. 4.7).
- Key findings and limitations.

The tool was piloted on five studies, and 20% of the extracted data were double-checked by a second reviewer for consistency. Data extraction and coding were managed with NVivo 14 for qualitative dimensions and Excel/SPSS (<https://www.ibm.com/products/spss> (accessed on 30 August 2025)) for descriptive statistics.

3.6. Quality Appraisal and Risk of Bias

Quality was assessed independently by two reviewers using design-appropriate tools: MMAT 2018 for quantitative/mixed-methods [29], CASP for qualitative [32], and AACODS for policy/official documents [33].

Each criterion was scored (Yes = 1; No = 0; Unclear = 0.5; AACODS: 0–2 per domain). Studies were classified as:

- High quality ($\geq 80\%$),
- Acceptable (60–79%),
- Low ($< 60\%$).

Unlike many reviews, this study presents a summary table (Table 1) in the main text showing score distribution by study type and criterion.

Biases explicitly considered:

- Language bias (English/French restriction excluding Arabic, mitigated via abstract screening).
- Publication bias (over-representation of positive results).

3.7. Data Synthesis and Analyses

Findings were synthesized narratively, structured around the three RQs, supported by:

- Descriptive statistics (year, methodology, themes, SDG alignment).
- Cross-tabulations with chi-square tests.
- Visualizations (bar, pie, bubble).
- A SWOT/TOWS matrix [34].
- A global bibliometric review was considered only to frame Morocco's positioning; it is cited narratively and was not part of the included evidence synthesis [26].
- A policy-alignment matrix mapping ESD 2030 areas vs. Morocco's NSDS [27].

Where data allowed, PROGRESS-Plus equity indicators (residence, gender, SES) were coded and visualized [35]. Coding was performed in NVivo, with intercoder reliability checks.

3.8. Compliance with PRISMA 2020

This systematic review was designed and conducted in full compliance with the PRISMA 2020 guidelines [27]. A pre-registered protocol was developed and deposited in the Open Science Framework (OSF), ensuring methodological transparency and traceability. The review followed all key stages recommended by PRISMA: systematic search across multiple international databases (Scopus, Web of Science, ERIC, ProQuest, Education Source, ScienceDirect, SpringerLink, and Google Scholar), explicit inclusion and exclusion criteria, independent double-screening with inter-rater agreement measured by Cohen's kappa, structured data extraction using standardized forms, and critical quality appraisal with validated tools (MMAT, CASP, and AACODS). A PRISMA flow diagram was used to report the selection process, while the narrative and statistical synthesis was organized around the predefined research questions. Biases and methodological limitations were explicitly acknowledged to strengthen the validity and reproducibility of the findings.

3.9. Ethical Considerations and GenAI Disclosure

This review uses only publicly available secondary data; thus, no ethics approval was required. Procedures followed the Declaration of Helsinki [36].

No generative AI was used for data collection or analysis; limited AI-assisted language polishing and figure formatting were employed with full responsibility [37].

4. Results and Discussion

This section presents the findings of the critical integrative review, aligning with the study objectives, and drawing on 35 peer-reviewed and policy-oriented studies that examined Environmental Education (EE) in Morocco across policy, pedagogical,

and post-pandemic dimensions. The selection process adhered to PRISMA 2020 guidelines and is summarized in Figure 1 (PRISMA flow diagram), ensuring transparency and reproducibility [27].

For clarity and alignment with the research design, each sub-section explicitly addresses one of the research questions (RQs):

- Section 3.1—RQ1: To what extent do Moroccan EE policies and practices align with global frameworks and post-pandemic priorities?
- Section 3.2—RQ2: What structural and institutional barriers limit equitable and context-sensitive EE?
- Section 3.3—RQ3: Which strategies—especially participatory, place-based, and justice-oriented approaches—can enhance EE’s transformative potential in Morocco?

To provide immediate insight into the robustness of the evidence base, the quality appraisal of the included studies is presented upfront (Table 1). The appraisal was conducted using the MMAT tool for quantitative and mixed-methods designs [29], CASP for qualitative research [32], and AACODS for policy and official documents [33].

The overall evaluation yielded the following distribution:

- 9 studies ($\approx 26\%$) were rated High quality ($\geq 80\%$), including several empirical works on EE pedagogy and institutional practices [11,38,39].
- 24 studies ($\approx 69\%$) reached Acceptable quality (60–79%), most of which address programmatic evaluations and NGO-led initiatives [22,40,41].
- 2 studies ($\approx 6\%$) were rated Low quality ($< 60\%$), often due to weak methodological reporting or limited generalizability.

Beyond the quality appraisal, it is equally important to situate the included studies in terms of their context, methodological orientation, and key findings. Table 2 provides a structured synthesis of the 35 studies, highlighting their study settings, methods, as well as the main obstacles and good practices identified. This overview serves as the empirical foundation for the thematic analysis presented in Sections 3.1–3.3.

Table 2. Summary of the 35 studies included in the review, with study context, methodological approach, identified obstacles, and good practices.

No	Authors & Year	Context/Education Level	Study Type & Methodology	Main Obstacles	Levers/Good Practices
1	El-Batri et al. [11]	Primary schools (4, Morocco)	Quantitative (survey & test)	Limited contextualization; socio-economic inequalities	Adapt content to local context; practical activities fostering learning
2	El-Batri et al. [12]	Teachers (636, Fès–Meknès)	Quantitative (survey)	Lack of training/resources; reliance on traditional methods	Continuous professional development; active pedagogy; interdisciplinary integration
3	Sayad et al. [42]	High schools (6, Fez)	Quantitative (survey—teachers & students)	Lack of admin support; limited resources	Student & teacher willingness to engage in EE
4	Cherai et al. [38]	15 schools (Tangier–Tétouan–Al Hoceima)	Mixed-method (survey + testimonies)	Heavy workload; lack of follow-up/materials	Teacher training; collaborative projects; participatory approaches
5	Ameziane [43]	Secondary LES curricula (10 high schools)	Documentary + Survey	Limited environmental content; overly informative approach; weak resources	Stronger curricular integration; diversified pedagogical methods

Table 2. Cont.

No	Authors & Year	Context/Education Level	Study Type & Methodology	Main Obstacles	Levers/Good Practices
6	Sbai et al. [44]	High schools—Bouarfa & Jerada (Eastern Morocco)	Quantitative (survey + multivariate analysis)	Predominantly anthropocentric conceptions; limited ecological representation	Adapt pedagogy to include ecocentric values; context-sensitive content
7	Bouhazzama & Mssassi [45]	Tangier Summer University (30 participants)	Qualitative (case study; observation + interviews)	Limited resources; theory–practice gap; insufficient funding	Experiential learning workshops; emotional/contextual learning
8	El Moussaouy et al. [46]	Oujda Academy (90 physics & biology teachers)	Mixed-methods (documentary + survey)	Low EE integration; dominance of informative pedagogy; lack of interdisciplinarity	Curricular reform; teacher training; active, integrated pedagogies
9	El Azzouzi et al. [47]	Fez–Meknes (120 physics teachers)	Quantitative (survey)	Lack of curricular contextualization; weak teacher training	Curricular innovation; contextualized EE to stimulate engagement
10	Eco-Schools Morocco [48]	National (5000+ schools)	Documentary—Institutional report	Dependence on external funding; territorial disparities	Community-based approaches; concrete projects (gardens, recycling, water)
11	Daoudi [49]	Morocco—prospective analysis	Theoretical (prospective scenarios)	Absence of renewable energy training in schools	Integrate energy topics into curricula
12	Daoudi [50]	Morocco—policy analysis	Documentary (policy review)	Education–energy sector disconnect	Align curricula with green transition & labor market
13	Bekhat et al. [51]	High schools (various regions)	Quantitative (survey)	Traditional pedagogy; limited resources	Continuous training; ecological field trips
14	Rachad & Oughdir [52]	Fès—150 high school students	Quantitative (survey; pre/post-test)	Digital divide; lack of practical tools	E-learning improved outcomes; supports blended learning
15	Idrissi [53]	Pre-service STEM teachers (Fès–Meknès)	Quantitative (survey)	Low climate content knowledge; weak training support	High motivation; integrate climate modules in training
16	El-Alami & Cit [54]	Morocco—general population (>500)	Quantitative (national survey)	Limited knowledge; low pro-environmental behaviours	Awareness campaigns; integration into education
17	Fanini & Fahd [55]	Primary schools (Tétouan)	Experimental (storytelling intervention)	Low student engagement without cultural relevance	Storytelling; use of local heritage
18	Guaadaoui et al. [56]	Morocco—national analysis	Conceptual (policy review)	Institutional fragmentation; regional disparities	Integrated national strategies; cross-sectoral planning
19	Ifqiren et al. [57]	96 Life & Earth Sciences teachers	Quantitative (survey)	Limited use of modelling; weak training in methods	Introduce modelling tasks; teacher professional development
20	Nourredine et al. [58]	Casablanca—public high school	Case study—Participatory action	Weak curricular integration; low awareness	Experiential/interdisciplinary projects; researcher–school partnerships
21	Laaloua [59]	8 high schools, Agadir (524 students)	Quantitative (survey + textbook analysis)	Limited human–environment links; weak multicultural lens	Enrich geography curricula; promote critical/multicultural thinking
22	Maaroufi et al. [60]	Oriental region	Regional review—Documentary	Regional disparities; lack of coordination	Context-adapted strategies; regional partnerships

Table 2. *Cont.*

No	Authors & Year	Context/Education Level	Study Type & Methodology	Main Obstacles	Levers/Good Practices
23	Rachad & Oughdir [61]	Primary schools (teachers/admins)	Quantitative (survey)	Weak experimental culture; lack of teaching materials	Develop experimental pedagogy; teacher training
24	Ait El Mokhtar et al. [62]	Secondary schools—SVT	Mixed-methods (surveys + practice analysis)	Weak teacher training in 21st-century skills	Project-based learning; ICT integration; SD-oriented skills
25	Riouch & Benamar [39]	Morocco—national perspective	Documentary (critical analysis)	Institutional fragmentation; regional disparities; weak training	Intersectoral coordination; regionalized programs
26	Zerrouqi et al. [63]	Middle schools—SVT textbooks	Documentary (content analysis)	Limited content; lack of local contextualization	Revise textbooks; include local themes
27	Ouzemri & Bensasi (2021) [64]	Morocco—primary curriculum	Mixed-method (curriculum analysis + policy review)	Curriculum–practice alignment gap	Update curriculum content; integrate EE dimension
28	El Alaoui, A. A. E., Abdelali, F., & Kafssi, M. [65]	Morocco—national level	Qualitative & policy analysis (documentary + institutional review)	Partial and uneven implementation of SDGs in education, weak governance, and fragmented strategies	Strengthen national coordination; reinforce teacher training; align curricula with SDG 4.7 and ESD 2030 Roadmap
29	Zerrouqi, Z., Iyada, A., & Bouamiech, M. (2016) [66]	Middle schools—SVT textbooks	Documentary (content analysis)	Limited content; local/global imbalance	Update textbooks; integrate local content
30	Abid et al. [67]	Secondary schools—SVT	Documentary (content analysis)	Uneven ESD integration	Harmonize ESD modules; strengthen interdisciplinary activities
31	UNESCO [68]	Morocco—national profile	Policy/institutional report	Weak EE/ESD integration; fragmentation	National commissions; supportive structures
32	Saayoun et al. [69]	Middle & high schools (243 teachers)	Quantitative (survey)	Cultural irrelevance; language issues	Teacher feedback loops; culturally adapted textbooks
33	Id-Babou et al. [23]	High schools—Guelmim (rural & urban)	Quantitative & qualitative (Q & interviews)	Incomplete biodiversity concept; weak pedagogical activities	Integrate biodiversity activities; curricular conceptualization
34	Idrissi Boutaybi et al. [70]	Gardening school for NEET youth	Qualitative (case study)	Barriers for vulnerable youth; limited resources	Place-based hands-on learning; partnerships; green jobs pathways
35	Lbadaoui-Darvas et al. [71]	Rabat universities—climate/air quality	Programmatic (project-based curriculum + sensors)	Limited monitoring coverage; climate vulnerability; resources	Sensor-based learning; Climate Club; capacity building; open data outreach

4.1. Reporting of Equity Indicators in the Included Studies

Research Question 1 (RQ1): To what extent do Moroccan EE studies report equity-related indicators such as sex, residence, or socio-economic status, and what patterns emerge from this reporting?

Beyond the pedagogical and institutional obstacles identified, the analysis highlights a notable weakness in the reporting of equity indicators. Among the 35 studies included, approximately one-third explicitly mention participants' sex or gender, and around 35–40% address territorial context (urban, rural, or regional). In contrast, fewer than 10% explicitly report socio-economic status, which is usually referred to only indirectly (e.g., resource inequalities or the vulnerability of NEET youth). In addition, some studies consider

school type or academic stream ($\approx 40\%$), but more as a contextual factor than as a formal equity indicator.

This lack of disaggregated data limits the ability to identify and analyze structural inequalities in access to and impacts of environmental education. To address this gap, future research should adopt a standardized framework for reporting equity indicators, drawing on the PROGRESS-Plus recommendations, the UNESCO ESD 2030 Roadmap, and SDG 4.7. Such standardization would enhance the comparability of results, support more inclusive education policies, and ensure that environmental education initiatives better respond to the diverse needs of students, taking into account their gender, location, or socio-economic background. To illustrate this point, Appendix A, Table A1 summarizes reporting of the equity indicators (sex/gender, residence, and SES) across the included studies.

4.2. Policy Alignment of Morocco's Environmental Education with the SDGs and ESD 2030 Roadmap

Research Question 2 (RQ2): How do Morocco's EE policies and practices align with international agendas, particularly SDG 4.7 and the UNESCO ESD 2030 Roadmap?

Overall, Morocco's environmental education (EE) framework—anchored in the National Sustainable Development Strategy (NSDS), the Eco-Schools program, and curricular integration—shows partial convergence with international agendas, such as the Sustainable Development Goals (SDGs) and the UNESCO ESD 2030 Roadmap [1,72]. Alignment is most visible at the discursive and policy levels, whereas implementation remains uneven across territories and school types [11,22].

A persistent urban–rural divide structures opportunities for EE. Urban schools are more likely to benefit from trained educators, functional environmental clubs, and adequate material resources, while rural and peri-urban schools face infrastructural deficits, constrained budgets, and limited access to teacher training [39,40]. These disparities mirror patterns documented in other Global South contexts, such as sub-Saharan Africa and India [73,74].

Teacher education emerges as a critical gap. Despite frequent policy references to sustainability competencies, pre-service and in-service training programs seldom embed participatory, place-based, or critical EE approaches, yielding practices that are often informative rather than transformative [75,76]. Strengthening educator capacity thus appears pivotal for translating policy ambitions into classroom-level change [77].

At the institutional level, coordination remains fragmented. Environmental clubs—key vehicles for experiential and action-oriented EE—are frequently tied to short-term, donor-funded projects, without systematic integration into curricula, school governance, or monitoring frameworks [78,79]. National strategies often lack robust monitoring and evaluation (M&E) mechanisms, sustainable financing, and standardized guidance, which undermines scalability and continuity [80].

These findings, derived from the 35 studies retained in this review, reveal a structural fragility that transcends the Moroccan context. For instance, the heavy reliance of environmental clubs on external donors mirrors similar limitations observed in Algeria and Tunisia, where EE initiatives are predominantly project-based and lack long-term institutional anchoring. Likewise, the persistent deficit in teacher training reflects regional trends across Francophone Africa, where sustainability competencies are frequently referenced in policy frameworks but rarely embedded in pre-service teacher education. Conversely, comparative experiences suggest promising avenues: in Algeria, the integration of EE clubs within school governance structures has strengthened their continuity, while in Tunisia, the incorporation of EE modules into civic education curricula has fostered a more systemic approach. Such insights highlight that Morocco's challenges are simultaneously national and regional, requiring not only internal reforms but also Maghreb-wide cooperation.

In sum, while Morocco demonstrates strong discursive alignment with global sustainability frameworks, the transformative potential of its EE system remains constrained by structural inequities, insufficient teacher capacity, and fragmented institutional support. These limitations, and the strategies to overcome them, are further detailed in Table 3, which synthesizes the main structural barriers and context-sensitive strategies to enhance EE delivery and equity, and in Table 4, which highlights post-pandemic challenges and emerging opportunities for more resilient environmental education policies.

4.3. Health–Environment Integration and One Health Perspectives in Morocco

Research Question 3 (RQ3): To what degree are health–environment linkages, including One Health perspectives, integrated into EE research and practice in Morocco?

Beyond the partial policy alignment with the SDGs and the UNESCO ESD 2030 Roadmap, Morocco’s environmental education (EE) framework shows important gaps in integrating health–environment linkages. Circulars of the Ministry of National Education (MEN) over the last decade have emphasized sustainability, citizenship education, and hygiene, while the Mohammed VI Foundation for Environmental Protection has issued guidance on Eco-Schools and youth engagement, framing environmental stewardship as a lever for public health and well-being. Nevertheless, explicit One Health approaches—bridging human, animal, and environmental health—remain absent from formal curricula and are not yet pilot-tested in school settings, despite being recommended in academic and NGO reports as a strategic direction.

Several Morocco-specific examples highlight emerging intersections between health and environment. First, the COVID-19 pandemic underscored the challenge of managing medical waste from vaccination campaigns, which raised sanitary and ecological risks and sparked calls for integrated awareness programs in schools [81]. Second, initiatives in Casablanca linking sustainable water management and wastewater reuse to educational projects illustrate how environmental issues can be contextualized as public health concerns [58]. Third, universities in Rabat have implemented sensor-based curricula on air pollution and climate vulnerability via climate clubs and open-data platforms, though these remain limited to higher education [71]. Finally, the Eco-Schools program broadly frames hygiene, waste, and water management as intertwined with student health and well-being, even if no explicit One Health framework is applied [82].

Yet, beyond these isolated cases, systematic health–environment integration remains underdeveloped in Moroccan EE. Future reforms should explicitly embed One Health perspectives into school programs, bridging environmental awareness with health education to build resilience against both ecological and sanitary crises. Additional Moroccan examples are summarized in Appendix B, Table A2.

4.4. Implementation Architecture and Monitoring Framework

❖ Teacher professional development (PD) modalities.

A robust teacher PD framework is required to enhance capacity in environmental education (EE). We recommend a three-track approach:

1. Stackable micro-credentials (15–30 h each) on themes such as place-based pedagogy, project-based EE, climate–health linkages, and citizen science. These can be offered online with blended workshops and accumulated toward an annual EE certificate.
2. Practicum-oriented modules embedded in schools, where teachers implement mini-projects (e.g., biodiversity gardens, water audits, waste segregation) with student participation, submitting a short reflection report.

3. Local mentoring centers hosted by regional teacher-training institutions or universities, providing mentoring triads (pedagogy, STEM/health, community engagement) to offer site visits, co-design support, and contextualized teaching resources.

❖ **Minimum national specifications for environmental clubs.**

To ensure equity and quality across schools, a light national framework should be established:

- Baseline micro-grants per school/year to support a flagship project.
- Yearly planning templates (max. two pages) including objectives, activities, and student roles.
- Light monitoring and evaluation (M&E) using short activity briefs and outcome proxies (e.g., student leadership, one community partnership).
- Municipal links, ensuring each club partners annually with a city service (water, sanitation, parks, waste).
- Equity safeguards, requiring at least 40% female membership and inclusion of students from multiple grade levels.

❖ **Core SDG 4.7 dashboard indicators.**

To track progress and equity, a national dashboard should include:

- Prevalence of actively functioning clubs (% of schools with a registered, active club).
- Hours of EE-integrated instruction (per student, per term).
- Teacher PD completion rates (% completing ≥ 1 micro-credential annually).
- Practicum project implementation (% of schools implementing at least one EE project/year).
- Student participation rates (% engaged in EE clubs or projects).
- Urban–rural equity gaps (absolute differences in active clubs and PD rates).
- Inclusion indices (share of girls and students from disadvantaged backgrounds in clubs).

❖ **Governance and funding.**

We propose the establishment of an Interministerial EE Steering Committee, chaired by the Ministry of National Education (MEN), with representatives from the Environment, Health, Higher Education, and Interior ministries, and supported by the Mohammed VI Foundation for Environmental Protection. A Technical Secretariat within MEN would manage the PD platform, club registry, and dashboard. Funding could come from MEN budget lines, regional councils, municipal services, CSR partnerships (utilities, green industries), and targeted grants.

❖ **Phased implementation with equity focus.**

- Phase 1 (Year 1): Secretariat setup; pilot 3–4 regional mentoring hubs; launch 2 micro-credentials; provide micro-grants to the most underserved 20% of schools.
- Phase 2 (Years 2–3): Expand mentoring hubs nationwide; full PD catalogue (6–8 micro-credentials); micro-grants for 50% of schools; integrate dashboard reporting into MEN portal.
- Phase 3 (Years 3–4): National coverage of clubs and PD; external evaluation; equity gap reduction targets (close $\geq 50\%$ of urban–rural disparities); institutionalize recurrent funding.

4.5. Identifying Systemic and Structural Barriers to Moroccan Environmental Education

Across the 35 included studies, several system-level constraints consistently limit the transformative potential of Environmental Education (EE) in Morocco. These mutually

reinforcing barriers help explain the persistent policy–practice gap between national ambitions and school-level realities. A consolidated summary of barriers and context-sensitive strategies is provided in Table 3.

Table 3. Structural barriers and context-sensitive strategies for strengthening environmental education in Morocco.

Dimension	Identified Barriers	Recommended Strategies
Territorial inequality	Urban–rural/peri-urban disparities in infrastructure, staffing, connectivity, and functionality of environmental clubs [13,42,46,83].	Targeted resourcing and operational support for under-served schools; minimum service standards for EE inputs
Teacher training	Limited integration of participatory, place-based, and critical EE pedagogies in pre-service/in-service programs [84–86].	Systematic mainstreaming of EE in teacher education; practice-based modules, mentoring, and school-based inquiry
Institutional coordination	Reliance on short-term, project-based initiatives; weak guidance and uneven practices [11,12,24,79].	Stable funding lines; standardized monitoring and evaluation; participatory school governance for EE
Policy–practice gap	Alignment with SDG 4.7/ESD 2030 but uneven implementation guidance (roles, resources, indicators), especially in rural/peri-urban contexts [1,13,87]	Locally grounded delivery models; multi-stakeholder engagement (schools–communities–NGOs–municipalities)

Building on Table 3, four interconnected barrier domains emerge:

1. **Territorial inequality.** Pronounced urban–rural/peri-urban gaps in infrastructure, staffing, and the functionality of environmental clubs restrict the continuity of EE in under-resourced areas. These findings echo national patterns [13,42] and resonate with broader evidence from the Global South, where structural disparities remain a major determinant of educational equity [83].
2. **Insufficient teacher preparation.** Despite curricular references to sustainability, pre-service and in-service programs seldom embed participatory, place-based, or critical pedagogies. As a result, practice often remains informational rather than transformative, which undermines students’ capacity for critical ecological thinking [84–86]. This gap illustrates the need to shift from knowledge transmission toward competency-oriented approaches in line with Education for Sustainable Development (ESD).
3. **Fragmented institutional coordination.** EE delivery is frequently dependent on short-term, donor-driven projects with limited integration into national curricula or governance frameworks. The lack of standardized guidance and light-touch monitoring and evaluation (M&E) mechanisms constrains both continuity and scalability [11,12,22,79]. This reliance on temporary initiatives reflects a systemic fragility that hampers the institutionalization of EE.
4. **Cross-cutting policy–practice gap.** While national policies formally align with SDG 4.7 and the UNESCO ESD 2030 Roadmap, uneven implementation guidance—especially regarding roles, resources, and indicators—prevents effective local adaptation. The issue is particularly acute in rural and peri-urban contexts where resource constraints are most severe [1,13,87].

Collectively, these barriers reveal why Morocco struggles to move from declarative commitments to transformative action in EE. They highlight a persistent disconnect between policy frameworks and grassroots realities, a challenge shared by many countries attempting to operationalize SDG 4.7 [1,72]. However, the strategies summarized in Table 3

suggest that more context-sensitive, participatory, and structurally embedded interventions could gradually bridge this divide.

4.6. Post-Pandemic Dynamics and Policy Opportunities for Environmental Education in Morocco

The COVID-19 pandemic profoundly reshaped Morocco's EE landscape by exposing pre-existing structural vulnerabilities while simultaneously triggering adaptive responses. Prolonged school closures, compounded by the digital divide, severely disrupted EE delivery—particularly in rural and marginalized areas—echoing international evidence on learning loss, unequal access to remote schooling, and the fragility of extracurricular programming [14,16].

At the same time, educators and school clubs demonstrated resilience by integrating health–environment linkages (e.g., hygiene education, medical-waste awareness, and local stewardship projects). However, these practices often remained fragmented, dependent on individual leadership, and poorly institutionalized [17,24,25,88]. Emerging studies on digital and hybrid pedagogies highlight further opportunities to sustain participation, inclusion, and resilience in contexts where in-person instruction is disrupted [18,20].

Taken together, the crisis has opened a policy window to move beyond ad hoc initiatives and embed more systemic reforms. Specifically, the post-pandemic context offers a unique opportunity to:

- Institutionalize health–environment education, including One Health perspectives linking human, animal, and ecosystem health;
- Expand teacher professional development focused on participatory, place-based, and critical pedagogies;
- Embed adaptive hybrid approaches into school governance, ensuring continuity during future crises;
- Align financing and monitoring frameworks with ESD 2030 priority areas, thereby bridging the gap between global policy frameworks and local implementation [1,84,89].

A consolidated summary of post-pandemic challenges and actionable opportunities is presented in Table 4 below.

Table 4. Post-pandemic challenges and policy opportunities for environmental education in Morocco.

Theme	Challenges Identified	Opportunities for EE
Educational disruptions	School closures; uneven readiness for remote/hybrid delivery; limited guidance for EE activities online [14,15].	Embed health–environment/One Health content in hybrid, flexible models; provide low-tech options and classroom–community projects that can continue during disruptions [88,89].
Exacerbated inequalities	Widened digital and resource gaps in rural/peri-urban contexts; uneven access to clubs and materials [16].	Targeted investment in devices/connectivity and EE kits; community-based initiatives with local authorities/NGOs; equity-sensitive monitoring of participation/outcomes [1].
Ad hoc adaptations	Reliance on individual leadership; project discontinuity; limited institutional anchoring [24,25].	Institutionalize clubs with baseline grants and light-touch M&E; formalize stewardship projects in school plans; create simple continuity protocols for crises
Policy window	Heightened awareness not yet translated into system-level reforms [90].	Strengthen teacher PD (participatory/place-based EE; micro-credentials); integrate EE into standards and appraisal; align finance and indicators with ESD-2030 priority areas [1,84].

In sum, COVID-19 exposed critical vulnerabilities but also catalyzed innovations that can be scaled—provided they are anchored within institutional frameworks. Future priorities include sustained teacher training, stable funding lines for environmental clubs, structured hybrid delivery models, and equity-focused monitoring systems. These elements are essential for ensuring that post-pandemic EE in Morocco is both resilient and transformative, bridging global commitments with local realities.

4.7. Bibliometric and Thematic Profile of the Reviewed Studies

A bibliometric and thematic overview of the 35 studies included in this review is presented in Figure 2a–f.

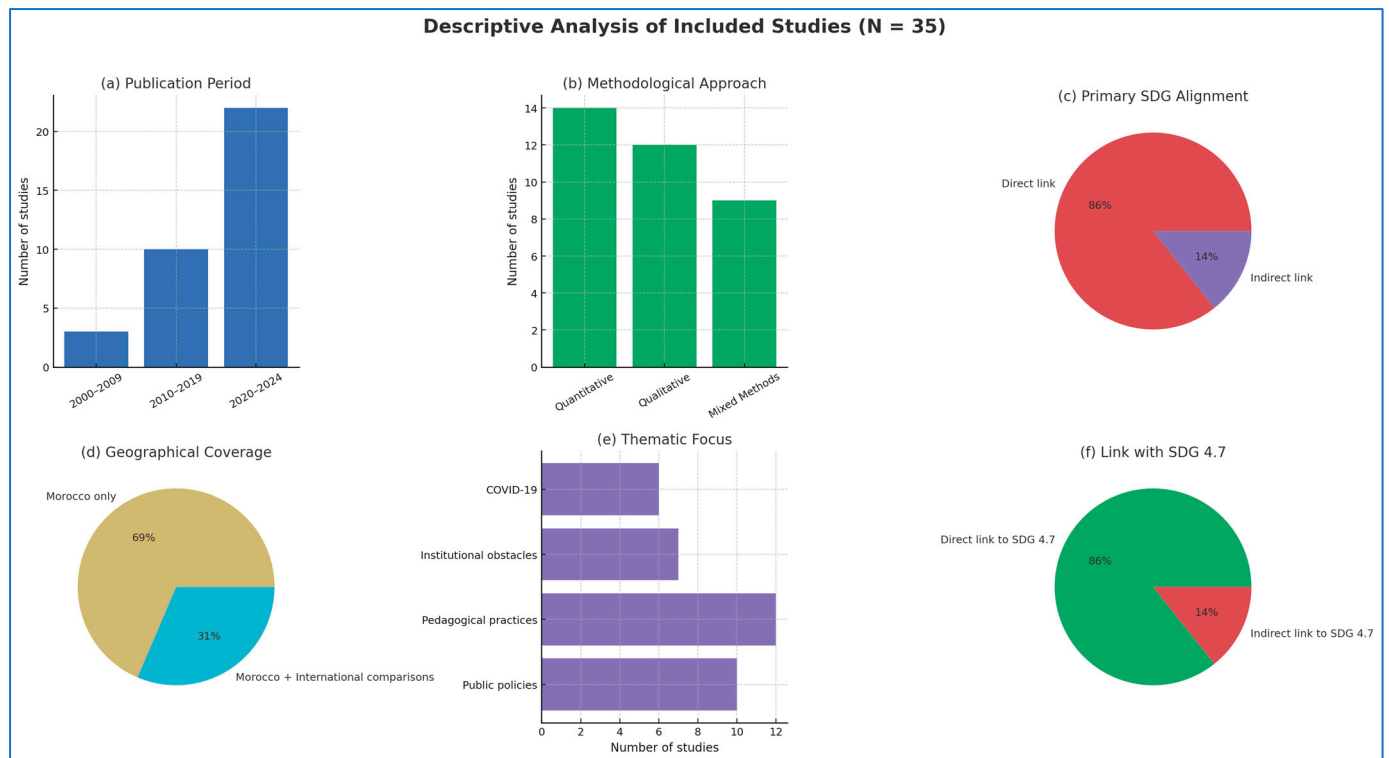


Figure 2. Descriptive characteristics of the 35 studies included in the review.

- Publication period—Three distinct phases were identified: a low output between 2000 and 2009, moderate growth during 2010–2019, and a pronounced surge after 2020 associated with the COVID-19 pandemic [Figure 2a].
- Methodological approach—Quantitative designs predominate (40%), followed by qualitative (34%) and mixed-methods (26%), with integrated designs gaining visibility after 2017 [Figure 2b].
- Primary SDG alignment—86% of studies are directly linked to the Sustainable Development Goals (mainly SDG 4.7), while 14% connect indirectly via SDGs 3, 6, and 13 [Figure 2c].
- Geographical coverage—69% of studies focus solely on Morocco, whereas 31% include international comparisons [Figure 2d].
- Thematic focus—The most common areas are pedagogical practices (31%), institutional obstacles (20%), COVID-19 integration (20%), and public policy (14%) [Figure 2e].
- SDG 4.7 linkages—86% explicitly connect with SDG 4.7, while 14% do so indirectly [Figure 2f].

The descriptive trends reveal both progress and enduring gaps in Morocco’s environmental education (EE) research landscape.

First, the temporal distribution (Figure 2a) highlights a sharp acceleration after 2020, with more than 60% of studies published in the 2020–2024 period compared to only 9% before 2010. This surge reflects the catalytic effect of COVID-19, confirming that crises often act as accelerators of sustainability research and policy attention [1,40].

Second, methodological segmentation (Figure 2b) shows the predominance of quantitative approaches in school-based EE (e.g., structured surveys, standardized assessments). Qualitative and mixed-methods designs, however, are more frequently applied to policy analysis and participatory interventions. The rise in mixed-methods since 2017 suggests progress toward triangulation and holistic inquiry, though overall methodological integration remains modest [91,92].

Third, alignment with international frameworks is strong: 86% of the studies directly reference SDG 4.7 (Figure 2c,f), demonstrating Morocco’s discursive anchoring in global sustainability agendas. Yet, many initiatives remain localized and project-based, revealing a gap between rhetorical alignment and systemic institutionalization [1,72,80].

Fourth, geographical coverage (Figure 2d) reveals a predominantly national focus (69%), with limited international benchmarking (31%). This imbalance underscores the importance of domestic concerns but also signals missed opportunities for adaptive learning across contexts [73,93].

Finally, thematic distribution (Figure 2e) emphasizes pedagogical practices (31%) at the expense of governance and institutional dimensions (20%). The integration of COVID-19 as a thematic axis (20%) highlights a growing recognition of health–environment linkages and the role of EE in building resilience during crises [15,36,39].

To consolidate these descriptive findings and their interpretive implications, Table 5 provides a comparative synthesis that juxtaposes the key bibliometric results with their analytical significance. This integrative view facilitates the transition from descriptive patterns to critical interpretation.

Table 5. Comparative synthesis of descriptive results and interpretive implications (N = 35 studies).

Dimension	Key Result	Interpretation/Implication
Publication period	Three phases: low output (2000–2009, 9%), moderate growth (2010–2019, 28%), surge post-2020 (63%).	COVID-19 acted as a catalyst, intensifying EE research. Crises can mobilize scientific and institutional attention.
Methodological approach	40% quantitative, 34% qualitative, 26% mixed. Mixed methods rising after 2017.	Segmentation reflects different research aims but limited triangulation. Growing use of mixed designs signals a positive trend toward integrative approaches.
SDG alignment	86% direct link to SDG 4.7; 14% indirect via SDGs 3, 6, 13.	Strong discursive integration into global agendas. Yet, systemic institutionalization remains weak, limiting impact.
Geographical coverage	69% Morocco only, 31% comparative.	Limited international benchmarking restricts policy transfer and cross-context learning.
Thematic focus	Pedagogy (31%), institutional barriers (20%), COVID-19 (20%), policy (14%).	Pedagogy dominates while governance and institutional analyses are underexplored. Pandemic themes highlight health–environment linkages.
Link with SDG 4.7	86% explicit, 14% indirect.	Confirms Morocco’s anchoring in SDG 4.7 but remains largely declarative; stronger operationalization is needed.

4.8. Strengths, Weaknesses, Opportunities, and Threats Shaping the Future of Environmental Education in Morocco

Overall, these descriptive insights show that Moroccan EE research has moved toward greater volume, policy relevance, and thematic diversity over the past two decades—especially in the post-pandemic period. However, the evidence base still exhibits methodological silos, a predominantly national lens, and limited institutional mainstreaming of SDG-aligned frameworks. These features motivate the SWOT analysis below (Tables 6 and 7), which identifies the strengths, weaknesses, opportunities, and threats shaping the future of EE in Morocco.

Table 6. Strengths and Weaknesses of Moroccan EE (2010–2024).

Strengths	Weaknesses
- Steady growth in EE-related publications since 2015, reflecting rising academic and institutional interest (Figure 2a,b).	- Geographic concentration of studies in urban and coastal regions; underrepresentation of rural and mountain areas (Figure 2c,d).
- Diverse methodological approaches, including quantitative, qualitative, and mixed methods, enabling triangulation of findings (Figure 2e,f).	- Limited longitudinal and experimental designs, reducing capacity for causal inference.
- Increasing thematic diversification, covering policy, pedagogy, community engagement, and post-pandemic adaptation.	- Fragmentation in data sources and inconsistent operational definitions of EE indicators, hindering cross-study comparability.
- Emerging collaborations between academia, NGOs, and governmental actors, fostering interdisciplinary approaches.	- Scarcity of large-scale, nationally representative datasets.

Table 7. Opportunities and Threats for Moroccan EE (2010–2024).

Opportunities	Threats
- Alignment of Moroccan EE goals with the SDGs and the ESD 2030 roadmap, offering leverage for international funding and partnerships.	- Persistent socio-territorial inequalities in resources and teacher training, risking widening gaps in EE access and outcomes.
- Integration of health–environment education post-COVID-19, enhancing EE’s relevance for resilience and public health agendas.	- Vulnerability to political and funding shifts that can destabilize long-term EE programs.
- Potential for digital tools, citizen science, and place-based learning to extend EE’s reach to underserved areas.	- Climate-related crises and competing policy priorities may divert attention and resources from EE.
- Opportunities to institutionalize environmental clubs and embed participatory methods in teacher training.	- Risk of “project-based dependency” without sustainable institutional frameworks.

The SWOT translates the empirical patterns in Figure 2 into a strategic reading of Morocco’s EE landscape.

- **Strengths** such as expanded thematic coverage, methodological diversity, and growing interdisciplinarity demonstrate a system moving closer to international standards. They also confirm that Morocco is increasingly positioning EE within global sustainability frameworks [1,80].
- Yet, **weaknesses** remain pronounced. The geographic concentration of research in urban centers sidelines rural and mountain areas, which are precisely the regions most vulnerable to climate risks. Similarly, the lack of longitudinal and experimental designs weakens the capacity to evaluate the long-term impacts of interventions [91,92].
- **Opportunities** are significant: the alignment with SDG 4.7 and ESD 2030 opens avenues for international cooperation, funding, and scaling-up. Furthermore, the integration of health–environment dimensions in the wake of COVID-19 provides an

entry point for embedding EE into broader resilience and public health policies [40,88]. Digital tools and citizen science further represent vectors for democratizing EE access across Morocco's diverse territories.

- **Threats**, however, jeopardize these gains. Persistent inequalities in teacher preparation and resource allocation risk entrenching uneven access to EE. Additionally, policy volatility and dependence on external projects hinder institutional stability, while climate-related crises may shift policy priorities away from EE [73,93].

Synthesis. Framing these insights in the Discussion highlights that Morocco's EE is at a turning point. The country benefits from momentum created by post-pandemic urgency, global SDG alignment, and rising research output, but still faces systemic fragilities. To move forward, institutionalizing EE in teacher education, embedding participatory methods, and ensuring equitable territorial coverage appear essential. These recommendations directly address weaknesses while leveraging strategic opportunities, advancing the implementation of SDG 4.7 in a sustainable and context-sensitive manner.

4.9. Situating Moroccan Environmental Education Within the Global Research Landscape

Consistent with international bibliometric evidence, Morocco remains underrepresented within global EE scholarship, with dispersed lines of inquiry that call for coordinated national research agendas [26]. Situating Morocco's EE within regional and international trends enriches the interpretation of the descriptive and SWOT analyses, while also highlighting the structural nature of many challenges. Comparative evidence from the Global South—such as Kenya [86], India [94], and Brazil [95]—shows similar trajectories: a post-pandemic expansion of EE catalyzed by heightened awareness of health–environment linkages, yet consistently constrained by resource inequalities and fragmented governance structures. In addition, parallels can also be drawn with neighboring Maghreb countries such as Tunisia and Algeria, as well as with other Francophone African contexts. Research from these regions highlights similar systemic barriers, including territorial disparities in educational resources, insufficient teacher preparation in participatory and place-based approaches, and the predominance of project-based initiatives with limited institutional continuity. At the same time, initiatives such as Tunisia's integration of EE into civic education curricula and Algeria's school-based ecological clubs illustrate potential models of regional adaptation that could enrich Morocco's own trajectory. Positioning Morocco within this broader Maghreb and Francophone African perspective reinforces the argument that the challenges it faces are not only global but also deeply regional in nature, requiring both national reforms and cross-border cooperation.

Methodologically, the Moroccan corpus—dominated by survey-based quantitative designs—mirrors patterns observed in South Africa and Indonesia [96,97]. While such approaches are valuable for generating large-scale descriptive insights, they often fall short in terms of causal inference and longitudinal tracking. This descriptive dominance constitutes a critical limitation for evidence-informed policymaking. Without longitudinal or experimental designs, it remains difficult to assess the long-term effectiveness of interventions such as teacher training reforms, institutionalization of environmental clubs, or the integration of EE into core curricula. Future Moroccan research should therefore prioritize longitudinal cohort studies, quasi-experimental designs, and participatory action research, which would allow not only the monitoring of behavioural change over time but also the evaluation of causal impacts. Such methodological diversification is essential if Morocco's EE system is to move from descriptive diagnosis toward evidence-based reform and adaptive governance. By contrast, countries with more institutionally embedded EE systems, such as Costa Rica and Finland, adopt longitudinal, mixed-methods, and participatory action research frameworks. These designs not only enhance the robustness

of evidence but also provide feedback loops for adaptive policy refinement, demonstrating the benefits of embedding EE in governance structures and educational systems [72,98].

Morocco's post-COVID-19 reorientation—which incorporates elements such as hygiene promotion, medical-waste management, and community stewardship—is consistent with UNESCO's ESD-for-2030 roadmap [1], emphasizing resilience, systems thinking, and transformative action. However, the under-representation of institutional-barrier analyses in Moroccan research remains a critical limitation. Governance, financing, and monitoring mechanisms are decisive levers for sustaining EE programs, yet they remain insufficiently addressed in the literature [80,99].

Viewed through this comparative lens, Morocco's trajectory demonstrates clear alignment with global sustainability agendas but also reveals the need for targeted reforms. Priorities include:

- Broadening methodological diversity, moving beyond cross-sectional surveys to include longitudinal, participatory, and experimental designs.
- Deeper institutional embedding of EE through teacher education, environmental clubs, and structured monitoring and evaluation frameworks.
- Strengthening international partnerships for knowledge exchange and capacity building, ensuring that Morocco can benefit from and contribute to South–South and North–South cooperation in EE.

Taken together, these steps can accelerate progress toward SDG 4.7 while generating transferable lessons for other Global South contexts, positioning Morocco not only as a beneficiary of international frameworks but also as a potential contributor to global EE innovation.

4.10. General Synthesis

The integrative analysis of 35 studies highlights a dual dynamic in Moroccan Environmental Education (EE). On the one hand, policies show clear alignment with global agendas such as SDG 4.7 and the UNESCO ESD 2030 roadmap. There is also a post-pandemic expansion of themes linking health, waste management, and ecological stewardship. On the other hand, implementation remains uneven. It is constrained by teacher preparation gaps, fragmented governance, rural–urban disparities, and the fragile institutionalization of environmental clubs.

In a broader comparative context, Morocco's trajectory mirrors many Global South experiences: growing awareness and discursive progress, yet limited by resource inequalities and methodological uniformity. Countries with more embedded EE frameworks illustrate the value of mixed-methods, participatory approaches, and longitudinal research designs—areas where Morocco could advance. Comparable challenges, such as the rural–urban divide and donor-dependency of EE initiatives, have also been documented in sub-Saharan Africa [100] and India [101]. These parallels are not meant as direct equivalences but as knowledgeable references that shed light on structural similarities.

To our knowledge, this is the first systematic review specifically focusing on EE in Morocco. Previous Moroccan and Maghreb studies have mainly taken the form of descriptive case studies or program evaluations [11,66,102]. Our work differs by systematically synthesizing findings across 35 studies and positioning them within broader policy and pedagogical debates. This situates Morocco's experience within both national and regional discussions, while opening avenues for cross-learning with other Global South contexts.

Morocco now stands at a critical juncture. Consolidating post-COVID-19 gains and addressing structural inequities are decisive for moving from informational to transformative EE. Priority levers include strengthening teacher education, institutionalizing clubs,

reducing territorial disparities, and embedding monitoring frameworks. Expanding quasi-experimental studies, participatory action research, and equity-sensitive indicators (e.g., PROGRESS-Plus) will reinforce systemic progress. Stronger regional and international co-operation can also provide a comparative framework for innovation and policy transfer, ensuring that Moroccan EE contributes to and benefits from broader Global South dynamics.

Beyond the substantive findings, this review also reveals its own strengths and limitations: to our knowledge, it constitutes the first systematic synthesis of Moroccan EE with transparent PRISMA methodology and rigorous quality appraisal, yet it remains partly constrained by the descriptive dominance of the included studies, the underrepresentation of rural contexts, and linguistic biases excluding some Arabic sources. This reflexive assessment underscores both the robustness and the boundaries of the evidence base, highlighting the need for more longitudinal, equity-sensitive, and diversified research designs in the future.

To better illustrate these dynamics, Figure 3 presents a conceptual synthesis framework that highlights the links between policies, practices, systemic obstacles, and the recommendations identified in this review.

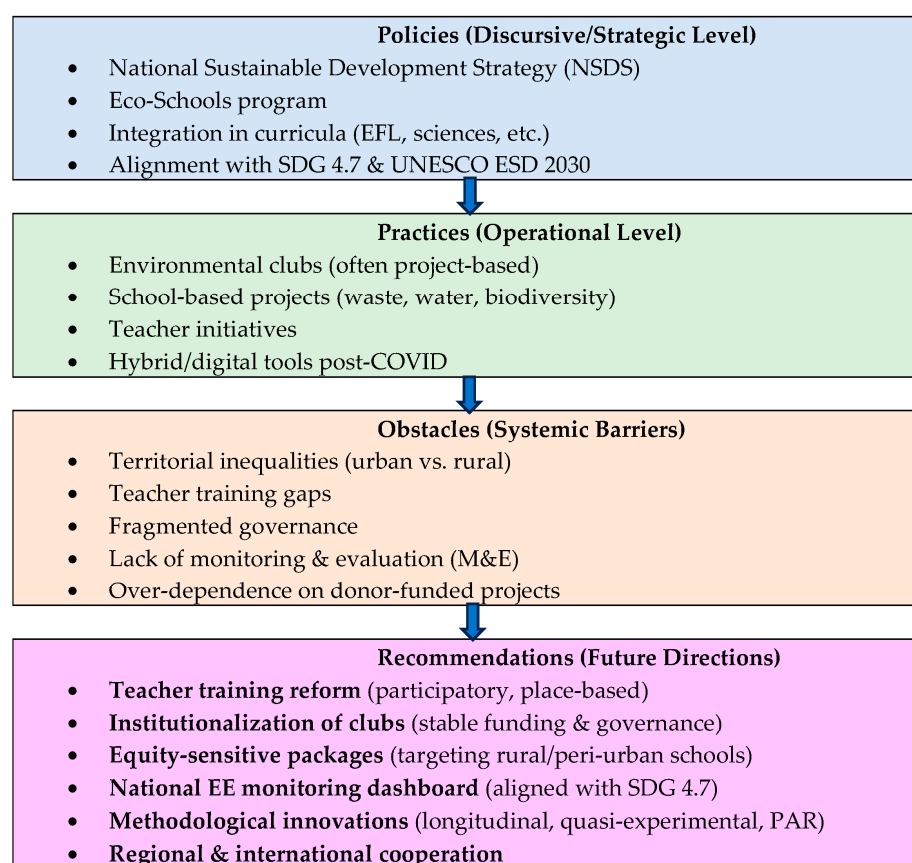


Figure 3. Conceptual synthesis of Moroccan Environmental Education (EE): Policies–Practices–Obstacles–Recommendations.

5. Limitations

This review has several limitations that must be acknowledged. First, language bias is present: Arabic-only publications were excluded due to translation constraints, which may have led to the omission of relevant local perspectives. Second, publication bias is likely, given the predominance of studies reporting positive or promising outcomes while negative or null findings are underrepresented. Third, the evidence base shows a clear geographic imbalance, with an overrepresentation of studies from urban and coastal

regions (Casablanca, Rabat, Tangier, Fez), whereas rural and inland areas are comparatively underexplored. Fourth, most included studies use cross-sectional designs, limiting the ability to establish causal inferences or assess long-term impacts of environmental education initiatives. Finally, global bibliometric reviews were not included in the evidence synthesis; rather, they are cited narratively to contextualize Morocco's publication gaps within the broader EE landscape [26]. These limitations underscore the need for future research to broaden linguistic inclusivity, diversify geographic coverage, and prioritize longitudinal and experimental designs to strengthen causal claims.

6. Conclusions

This critical integrative review reveals that, although Morocco's environmental education (EE) is formally aligned with SDG 4.7 and the UNESCO ESD 2030 roadmap, its implementation remains fragmented and uneven. Structural barriers—territorial disparities, limited teacher preparation, fragile governance, and the project-based nature of school clubs—continue to constrain the shift from informational to transformative EE.

Four strategic priorities emerge: (i) embed participatory and place-based pedagogy in teacher education; (ii) institutionalize environmental clubs with stable funding and light monitoring; (iii) address rural–urban inequities through targeted support; and (iv) adopt robust national indicators aligned with SDG 4.7. The post-COVID-19 context also presents opportunities to anchor One Health perspectives, consolidate hybrid delivery models, and enhance community stewardship.

Beyond national relevance, the findings position Morocco within broader Global South dynamics: similar structural constraints shape EE across low- and middle-income settings, but so do opportunities for locally grounded, scalable solutions. Looking ahead, advancing the field will require cumulative evidence that tracks reforms over time and informs adaptive governance. By acting on these levers, Morocco can accelerate its transition toward an inclusive, resilient, and transformative EE model—and offer lessons for regions facing comparable challenges.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su17219494/s1>, Table S1: Database search strategy, execution dates, and retrieval counts (January 2000–December 2024); PRISMA Checklist.

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Abbreviations

The following abbreviations are used in this manuscript:

EE	Environmental Education
SDG	Sustainable Development Goals
ESD	Education for Sustainable Development
NSDS	National Sustainable Development Strategy
MEN	Ministère de l'Éducation Nationale

Appendix A. Equity Reporting

Table A1. Reporting of equity indicators in the included studies (N = 35).

Equity Indicator	Number of Studies Reporting	Approx. Proportion	Comments
Sex/Gender	11	31%	Mostly in student surveys; limited disaggregated analysis.
Residence/Region	13	37%	Often coded as urban/rural or by region; seldom used analytically.
Socio-economic status	3	9%	Rare; usually indirect (resource inequalities, NEET youth).
Institutional context	14	40%	Reported as school type/track; typically, not framed as an equity lens.

Notes: Proportions are computed as count ÷ 35 and rounded to the nearest whole percent.

Appendix B. Health–Environment Integration Examples

Table A2. Health–environment integration examples in Moroccan environmental education studies.

Domain/Issue	Moroccan Example(s) Reported	Educational Integration	Comment/Gap	References
Medical waste (COVID-19)	Management of vaccination-related waste (masks, syringes, vials)	Awareness programs during the pandemic	Highlighted as an urgent challenge; no systematic curricular integration	[81]
Water management & reuse	Casablanca initiatives on sustainable water use and wastewater reuse	Linked to local educational projects addressing pollution and health risks	Localized pilots; not scaled nationally	[58]
Air quality & climate health	Rabat universities: sensor-based curricula on air pollution and climate vulnerability (climate clubs, open-data platforms)	Implemented in higher education	Not mainstreamed in schools	[71]
General health–environment framing	Mohammed VI Foundation guidance (Eco-Schools: hygiene, waste, water)	Environmental stewardship framed as linked to health and well-being	No explicit One Health framework applied	[82]

Note: This table consolidates illustrative cases reported across included studies; it is not an exhaustive mapping of interventions. Items listed here are referenced in the main text and were not used to expand the PRISMA count of included studies.

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