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Integrating Climate Literacy into Indian School Curricula through Open, Distance, and Digital Education: An Illustrative Multiple-Case Analysis

AMITABHA DATTA (Research Scholar)
Distance Education, Staff Training and Research Institute of Distance Education (STRIDE), Indira Gandhi National Open University (IGNOU), New Delhi, India. Maidan Garhi, New Delhi—110068

Abstract

Climate literacy is increasingly understood as a combination of climate-system knowledge, systems thinking, justice awareness, socio-emotional resilience, digital competence, and capacity for informed action. India has also developed substantial curricular, digital, and whole-school infrastructure that could support these outcomes. Yet the relevant initiatives remain dispersed across curriculum reform, learning platforms, broadcast systems, clubs, exemplar schools, civil-society programmes, and environmental assessment. This conceptual study asks how these assets can be connected through Open, Distance, and Digital Education (ODDE). It combines an integrative review, theory synthesis, document analysis, and an illustrative multiple-case analysis of seven Indian initiatives: the National Curriculum Framework for School Education 2023 and associated NCERT/CBSE resources; DIKSHA; PM e-VIDYA; Eco Clubs for Mission LiFE; PM SHRI Schools; WWF-India's One Planet Academy and Mission Prakriti; and TERI's GREEN Olympiad. Cross-case comparison shows complementary strengths in curricular legitimacy, scalable digital access, multimodal inclusion, learner action, whole-school sustainability, teacher mediation, and large-scale engagement. It also identifies five recurring gaps: weak curricular progression, fragmented programme governance, insufficient climate-digital teacher preparation, limited conversion of participation into assessed learning, and unequal access and contextualization. In response, the paper proposes the Climate Literacy through Open, Distance, and Digital Education (CL-ODDE) Framework, organized around seven interacting domains and equity-related cross-cutting principles. The cases are illustrative rather than evaluative; therefore, programme claims are treated as evidence of design and potential, not verified educational impact. The framework offers a context-sensitive curriculum pathway and an agenda for empirical validation in Indian schools.

Keywords: climate literacy; Open, Distance, and Digital Education; Indian school curriculum; illustrative cases; Education for Sustainable Development

Introduction

Climate change is simultaneously a scientific, social, ethical, and educational problem. School systems must help learners understand climate processes, interpret evidence, recognize unequal exposure to risk, manage climate-related emotions, and participate in adaptation and mitigation. International guidance accordingly moves beyond awareness toward interdisciplinary, action-oriented, and progressively sequenced climate learning (IPCC, 2023; UNESCO, 2021, 2024a). The challenge is not simply to add more environmental content. It is to organize curriculum, pedagogy, assessment, teacher learning, school operations, and community participation so that knowledge becomes informed agency.

India provides a particularly important setting for this inquiry. The National Education Policy 2020 and the National Curriculum Framework for School Education (NCF-SE) 2023 create policy space for experiential, competency-based, multidisciplinary, and technology-enabled learning (Government of India, 2020; NCERT, 2023). National digital and multimodal initiatives, including DIKSHA and PM e-VIDYA, can distribute resources across geography and language. Eco Clubs for Mission LiFE and PM SHRI Schools link learning to sustainable practices, while civil-society initiatives offer additional digital resources, projects, and assessment. These assets are significant, but they do not yet constitute a coherent climate-literacy system.

Open, Distance, and Digital Education (ODDE) is used here as an umbrella concept covering open educational resources, online and mobile learning, broadcast and print-supported distance provision, digitally enriched classroom learning, and networked professional development. ODDE is therefore not treated as a substitute for schools. Its value lies in connecting national resources with teacher mediation, local inquiry, peer interaction, and school-community action. This interpretation is especially relevant in India, where digital opportunity coexists with differences in connectivity, devices, electricity, language, disability access, and teacher capacity (Haleem et al., 2022; OECD, 2023a).

The paper addresses a gap between two bodies of scholarship. Climate-education research emphasizes knowledge, justice, emotion, participation, and action, whereas digital-education research commonly concentrates on access, infrastructure, platform governance,

and teacher capability. Few school-level frameworks connect these concerns and demonstrate how existing Indian initiatives might function as complementary parts of one system. Accordingly, the paper uses seven illustrative Indian cases to develop the Climate Literacy through Open, Distance, and Digital Education (CL-ODDE) Framework.

Objectives and Research Questions

The study has four objectives:

- To synthesize the contemporary meaning and theoretical foundations of climate literacy in digitally mediated school education;
- To analyse how seven illustrative Indian initiatives contribute to curriculum, access, pedagogy, teacher capacity, learner agency, assessment, and whole-school sustainability;
- To identify cross-case policy-practice gaps that constrain coherent implementation; and
- To develop a context-sensitive CL-ODDE Framework and curriculum pathway for Indian school education.

These objectives are addressed through four research questions:

- RQ1. What dimensions of climate literacy should guide curriculum integration through ODDE?
- RQ2. What complementary contributions and limitations are visible across the selected Indian cases?
- RQ3. What systemic gaps prevent these initiatives from operating as a coherent climate-literacy ecosystem?
- RQ4. How can the cases be synthesized into an implementable CL-ODDE Framework for Indian schools?

Conceptual and Theoretical Foundation

Climate literacy has expanded beyond factual knowledge of the climate system. Contemporary accounts combine scientific understanding with evidence evaluation, systems thinking, adaptation and mitigation, justice, emotional resilience, citizenship, and action competence (IPCC, 2023; NOAA, 2024; Olsen et al., 2024; Trott et al., 2023). Digital competence is increasingly inseparable from these outcomes because learners encounter climate claims through networked media and require skills to interpret data, evaluate

misinformation, collaborate, and communicate responsibly (OECD, 2023b). In this paper, climate literacy is therefore defined as the capacity to understand climate systems and risks, reason with evidence, recognize social and ethical dimensions, respond with resilience and hope, and participate in contextually appropriate collective action.

Education for Sustainable Development (ESD) supplies the normative foundation: education should enable environmentally responsible, socially just, and future-oriented choices (UNESCO, 2020, 2024a). Constructivist and transformative perspectives explain the pedagogical shift from transmission to inquiry, reflection, and action (Mezirow, 1997; Vygotsky, 1978). Effective climate education consequently involves local investigations, deliberation, scenario analysis, citizen science, and projects rather than factual recall alone (Leite, 2024; Monroe et al., 2019). Research on climate anxiety further indicates that pedagogy should acknowledge difficult emotions while cultivating efficacy, collective support, and meaningful participation (Olsen et al., 2024).

Three perspectives explain the ODDE component. Connectivism highlights access to changing knowledge through networks and open resources (Siemens, 2005). The Community of Inquiry framework shows that online learning depends on cognitive, teaching, and social presence rather than content availability alone (Garrison et al., 2000). TPACK locates successful use of technology in the teacher's integration of content, pedagogy, and technological knowledge (Mishra & Koehler, 2006). Applied to climate education, teachers require climate-content knowledge, inquiry and project pedagogy, digital and data capability, assessment literacy, and competence in facilitating ethical and emotional discussion.

Finally, ecological systems thinking locates the learner within interacting classrooms, schools, families, communities, institutions, and policies (Bronfenbrenner, 1979). UNESCO's whole-school approach similarly connects curriculum with governance, infrastructure, energy, water, waste, biodiversity, food, and community relationships (UNESCO, 2024b). These perspectives support a systems framework in which climate literacy emerges from aligned curricular, technological, pedagogical, institutional, and social conditions.

Table 1. Theoretical synthesis informing CL-ODDE

Perspective	Central proposition	Application in CL-ODDE
ESD and climate	Learning combines knowledge,	Defines multidimensional outcomes and

literacy	values, justice, resilience, and action.	curriculum progression.
Constructivist/ transformative learning	Understanding develops through inquiry, experience, dialogue, and reflection.	Supports projects, local investigation, citizen science, and action.
Connectivism and Community of Inquiry	Networks expand access; meaningful online learning requires teaching and social presence.	Links open resources with teacher mediation and collaboration.
TPACK	Teachers integrate content, pedagogy, and technology.	Defines climate-digital professional competence.
Ecological/ whole-school perspectives	Learning is shaped by interacting institutional and community systems.	Connects curriculum, operations, governance, and local partnerships.

Methodology

The study adopts a conceptual, document-based, illustrative multiple-case design. It does not claim to evaluate programme effectiveness. Instead, cases are used instrumentally to examine how existing Indian arrangements instantiate different components of a possible climate-literacy ecosystem. The analytical process combined four activities: an integrative review of recent climate-education and digital-education literature; synthesis of complementary theories; analysis of Indian curriculum, policy, programme, and organizational documents; and structured comparison of seven initiatives.

Cases were purposively selected for maximum conceptual variation. Inclusion required a direct connection to Indian school education and a discernible contribution to at least one of the following: curriculum integration, open digital resources, multimodal access, teacher development, learner action, whole-school sustainability, or environmental assessment. The seven cases are NCF-SE 2023 with associated NCERT/CBSE resources; DIKSHA; PM e-VIDYA; Eco Clubs for Mission LiFE; PM SHRI Schools; WWF-India's One Planet Academy and Mission Prakriti; and TERI's GREEN Olympiad. Together, they

span government and civil-society action, formal and co-curricular learning, digital and non-digital delivery, and curriculum, pedagogy, infrastructure, and assessment.

Each case was examined through four common questions: What function does it perform? What CL-ODDE domain does it illustrate? What implementation opportunity does it offer? What limitation prevents it from independently producing comprehensive climate literacy? Cross-case synthesis then identified complementarities, recurrent gaps, and design principles. Official or organizational statements about reach and programme features were treated cautiously: they demonstrate intended design and administrative scale but not independently verified learning outcomes. The framework was refined for conceptual coherence by checking whether every domain was supported by theory, visible in at least one case, and connected to a defined learner outcome.

The method has boundaries. Public documents may privilege programme intentions and favourable examples; the cases do not represent India's full diversity of states, boards, languages, ecological regions, or school types; and programme features can change. The resulting propositions therefore require expert review and field validation rather than being read as causal findings.

Illustrative Indian Cases

The cases below are the empirical-illustrative centre of the paper. Each is analysed as one component of a distributed national ecosystem, not ranked as a stand-alone programme.

NCF-SE 2023 and NCERT/CBSE curriculum resources

NCF-SE 2023 provides curricular legitimacy for environmental sustainability within a multidisciplinary, experiential, and competency-oriented school structure (NCERT, 2023). India's established infusion approach also allows environmental concerns to appear across science, social science, geography, mathematics, languages, arts, health, and vocational learning. The central opportunity is to replace scattered references with an explicit progression: observation and care in the foundational years; conservation and human-environment relationships at the preparatory stage; climate causes, energy, biodiversity, and data at the middle stage; and adaptation, mitigation, justice, green skills, policy, and community action at the secondary stage. NCERT and CBSE resources could then be converted into multilingual, accessible, QR-linked units containing local datasets, audio-visual explanations, field tasks, simulations, print alternatives, and teacher guides. The

limitation is that an infusion model can remain superficial when competencies, time, pedagogy, and assessment are not mapped across grades. This case therefore supplies the curricular backbone, while ODDE supplies distribution, enrichment, and continuity.

DIKSHA as a digital spine

DIKSHA illustrates scalable, curriculum-linked digital infrastructure for learners, teachers, and states. Within CL-ODDE, it could host grade-specific climate modules, regional case narratives, interactive maps, data interpretation, project templates, low-bandwidth downloads, accessible formats, portfolios, assessment items, and short teacher-development courses. Its strongest pedagogical use would connect digital prompts with local inquiry: learners might map shaded and unshaded temperatures, conduct water or waste audits, interpret results, and propose interventions. The same platform could develop teacher competence in climate science, interdisciplinary planning, misinformation literacy, socio-emotional facilitation, and project assessment. Yet access to a repository is not equivalent to coherent learning. Content quality, updating, language coverage, disability access, devices, connectivity, electricity, teacher mediation, and alignment with progression remain decisive. Platform analytics also measure access more readily than agency or sustained action. DIKSHA thus provides a national digital spine, but it needs a climate-specific architecture and offline, broadcast, and school-based complements.

PM e-VIDYA and multimodal inclusion

PM e-VIDYA combines digital, online, on-air, and other distance modes, including DIKSHA and educational television, with provisions intended to broaden access (Ministry of Education, n.d.). Climate content is well suited to such multimodality: television can present structured visual lessons; radio can carry local-language stories and community voices; mobile messages can prompt micro-activities; print workbooks can serve learners without connectivity; and teachers can organize discussion, feedback, and projects. Distributed modes can also support continuity during floods, cyclones, heat waves, landslides, and other disruptions while providing locally appropriate preparedness and resilience information. The main limitation is interaction. Broadcast content may raise awareness but remain one-directional unless paired with facilitators, peer exchange, assignments, feedback, and situated action. The case shows that an Indian climate-literacy strategy should be technology-diverse rather than internet-only, with each channel assigned a pedagogical function.

Eco Clubs for Mission LiFE as action learning

Eco Clubs for Mission LiFE illustrate learner participation around sustainable food, waste and e-waste, energy, water, healthy lifestyles, and reduced single-use plastics (Ministry of Education, 2025). Their digital network can support registration, coordination, resource sharing, documentation, and reporting, while school activities can transform learners from recipients into investigators and decision-makers. Water and energy audits, biodiversity documentation, e-waste studies, or food-system projects can connect science and mathematics with geography, technology, civics, economics, ethics, and local knowledge. Digital portfolios can record observations, datasets, reflection, proposed solutions, collaboration, and follow-up. The risk is ceremonial participation: pledges, event counts, photographs, or plantation totals do not establish conceptual understanding or durable behaviour. CL-ODDE therefore links every club activity to explicit curriculum outcomes, evidence-based inquiry, reflective assessment, and longitudinal review. This case contributes the action and community-engagement layer.

PM SHRI Schools as whole-school laboratories

PM SHRI Schools are intended as exemplars of NEP 2020 implementation, with sustainability located alongside pedagogy, assessment, infrastructure, inclusion, and digital provision (Ministry of Education, 2022). Solar energy, efficient lighting, gardens, waste management, plastic reduction, water harvesting, and biodiversity can turn school operations into observable curriculum. Learners can analyse energy generation, monitor water, map biodiversity, examine waste flows, test heat-reduction strategies, and participate in school decisions. Digital dashboards could support time-series analysis and comparison across ecological zones. The case's wider value depends on networking: exemplar schools should publish open project designs, datasets, teacher notes, and adaptations through DIKSHA and PM e-VIDYA and serve nearby schools as resource hubs. Green infrastructure alone, however, does not produce climate literacy; teachers must convert facilities into inquiry and participation. Unequal resourcing also limits transfer. PM SHRI therefore demonstrates whole-school alignment but requires open dissemination and designs feasible in ordinary schools.

WWF-India's One Planet Academy and Mission Prakriti

WWF-India's One Planet Academy combines digital courses, games, comics, e-books, and educator resources, while Mission Prakriti connects teacher-guided learning with projects on biodiversity, water, waste, food, and energy (WWF-India, 2026). Read together, they illustrate a digital-to-local cycle: access open resources; enable teachers to contextualize them; investigate school or community conditions; design and undertake projects; document outcomes; and use experience to inform further learning. This cycle aligns strongly with constructivist and transformative learning because learners act as investigators rather than audiences. It also demonstrates the value of civil-society expertise in resource design and teacher support. The limitation is variable integration with formal curriculum and assessment. Publicly reported reach indicates organizational scale, not independently established learner outcomes. The CL-ODDE lesson is that digital resources become educationally powerful when mediated by teachers, embedded in curriculum, enacted locally, and assessed reflectively.

TERI's GREEN Olympiad as scalable engagement and assessment

TERI's GREEN Olympiad provides structured environmental engagement for school students and illustrates the motivational and administrative feasibility of assessment at scale (The Energy and Resources Institute, 2026). Within CL-ODDE, this model could be broadened from knowledge-oriented competition toward climate-data interpretation, misinformation evaluation, scenario-based decisions, collaborative problem-solving, digital portfolios, local investigations, and evidence of sustained action. Such a design could provide national prompts while allowing contextual tasks. Its present conceptual limitation is characteristic of olympiad formats: individual cognitive performance may receive greater attention than collaboration, justice, socio-emotional competence, systems thinking, or community participation, and access may vary among schools. The case therefore contributes assessment reach and learner motivation but also clarifies why climate literacy requires multiple evidence sources rather than a single test.

Table 2. Cross-case synthesis of the Indian initiatives

Illustrative case	Principal contribution	Transferable opportunity	Central limitation

NCF-SE/ NCERT/CBSE	Curricular legitimacy	Map competencies across stages and subjects.	Infusion can remain fragmented.
DIKSHA	Digital infrastructure	Host multilingual resources, teacher learning, and portfolios.	Access does not ensure pedagogy or outcomes.
PM e-VIDYA	Multimodal access	Combine digital, TV, radio, print, and facilitation.	Broadcast can be one-directional.
Eco Clubs for Mission LiFE	Learner action	Link audits and projects to curriculum and reflection.	Activity counts may substitute for learning evidence.
PM SHRI Schools	Whole-school sustainability	Use operations as living laboratories and open resource hubs.	Exemplar resources may not transfer.
WWF-India programmes	Digital-to-local learning	Connect resources, teacher mediation, projects, and sharing.	Formal integration and independent outcome evidence vary.
TERI GREEN Olympiad	Scale and motivation	Extend assessment to data, decisions, portfolios, and action.	Competition may privilege individual factual knowledge.

Cross-Case Findings and Policy-Practice Gaps

The comparison reveals complementarity rather than redundancy. NCF-SE supplies curricular authority; DIKSHA offers a digital spine; PM e-VIDYA expands modality and resilience; Eco Clubs create an action space; PM SHRI connects curriculum with institutional practice; WWF-India demonstrates a resource-to-project cycle; and the GREEN Olympiad provides scale and motivation. No single initiative covers the complete sequence from intended curriculum to access, mediated learning, local action, assessment, and feedback. Their distributed strengths justify a framework based on coordination rather than another stand-alone programme.

Five gaps recur. First, curricular coherence is weaker than policy intent: climate themes may be present without a transparent progression of competencies across stages and subjects. Second, digital infrastructure is richer than climate-specific pedagogy. Platforms and broadcasts require inquiry tasks, interaction, feedback, and local application. Third, teacher preparedness is the principal mediating condition; teachers need climate-digital competence rather than separate courses in content and technology. Fourth, administrative indicators such as registration, access, completion, events, or reported reach can displace direct evidence of learning. Fifth, fragmentation across agencies and programmes makes it difficult to share standards, resources, assessment evidence, and implementation learning. Equity, multilingualism, disability access, local relevance, data privacy, and low-connectivity alternatives cut across all five gaps.

The CL-ODDE Framework

The Climate Literacy through Open, Distance, and Digital Education Framework treats climate literacy as an outcome of seven interacting domains. Policy and curriculum alignment specifies progressive competencies across stages and subjects. Open and multimodal infrastructure combines digital platforms, broadcast, mobile, print, and local facilitation. Digitally enriched pedagogy uses simulations, data, storytelling, virtual fieldwork, inquiry, citizen science, and projects. Teacher climate-digital competence integrates content, pedagogy, technology, emotional support, assessment, and community engagement. Learner agency positions students as investigators, collaborators, decision-makers, and contributors to adaptation and mitigation. Whole-school and community integration connects learning with school operations, local knowledge, institutions, and civil-society partnerships. Competency-based assessment gathers evidence of knowledge, systems and data reasoning, justice awareness, resilience, collaboration, and sustained action.

The domains are mutually dependent. Curriculum gives technology a purpose; multimodal infrastructure broadens access; teachers convert resources into learning; inquiry links global knowledge with local conditions; school and community settings create authentic action; and assessment feeds evidence back into curriculum and professional development. Equity, inclusion, multilingualism, accessibility, contextualization, learner well-being, ethical technology, and responsible data use operate as cross-cutting design principles. The intended

outcome is not a uniformly behaving 'green' learner but a climate-literate learner capable of evidence-informed, socially responsible, and context-sensitive participation.

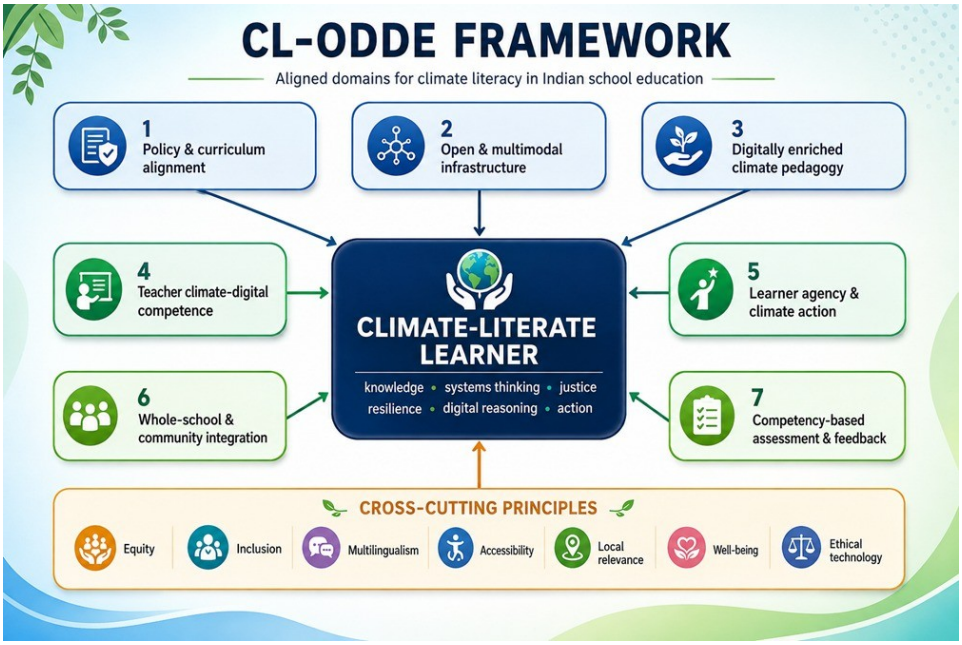

Table 3. Developmental curriculum pathway within CL-ODDE

Stage	Priority learning	Illustrative ODDE-supported practice	Assessment evidence
Foundational	Care, observation, weather, water, plants, responsible habits	Stories, audio, games, nature observation, picture records	Oral explanation, drawings, observation records
Preparatory	Conservation, waste, food, energy, local environments	QR resources, short videos, guided audits, local narratives	Simple logs, group products, reflection
Middle	Climate causes, systems, biodiversity, risk, data	Simulations, local datasets, citizen science, broadcast-plus-project units	Data interpretation, inquiry report, portfolio
Secondary	Adaptation, mitigation, justice, policy, green skills	Scenario analysis, interdisciplinary projects, digital collaboration	Reasoned decisions, project impact, peer/community feedback

Senior secondary	Futures thinking, research, innovation, leadership	Open courses, mentored research, interschool data networks	Research product, intervention evidence, public communication

Discussion and Implications

The cases reposition ODDE from a delivery mechanism to a curriculum-integration ecosystem. This extends conventional emphasis on flexibility and access: technology has transformative value only when linked to developmental curriculum, teacher mediation, social presence, authentic contexts, and multidimensional assessment. The synthesis also contextualizes TPACK. Climate-digital competence requires teachers to work across scientific uncertainty, local and Indigenous knowledge, ethical disagreement, misinformation, emotional responses, and action projects. Likewise, the whole-school perspective prevents a separation between what schools teach and how schools use energy, water, food, land, and materials.

For policy, the immediate priority is not a new national platform but a shared climate-literacy architecture. NCERT and relevant agencies could define stage-wise competencies and exemplar assessment tasks; digital and broadcast providers could map resources to that progression; teacher-development programmes could offer stackable, multilingual modules linked to classroom projects; and programme dashboards could distinguish reach, participation, learning, and longer-term action. A curated climate hub within existing infrastructure could connect national scientific content with state-specific languages, hazards, ecosystems, and livelihoods. Low-tech and accessible equivalents should be designed from the outset rather than added later.

For schools, implementation can begin with a small number of locally salient questions—heat, water, waste, air quality, biodiversity, food, flooding, or energy—and connect classroom concepts with school data and community knowledge. Eco Clubs should become curricular laboratories rather than parallel activities. PM SHRI and other well-resourced schools can support clusters by sharing open resources, mentoring, and adaptable project protocols. Assessment should triangulate quizzes and explanations with data tasks, portfolios, reflection, collaboration, and evidence of action; behavioural conformity should not be treated as the sole indicator of literacy.

The framework makes three contributions. Conceptually, it integrates climate literacy and ODDE within a single school-system model. Analytically, it shows how seven Indian initiatives supply complementary components while revealing the spaces between them. Practically, it translates theory into a stage-wise pathway and coordination agenda. Its transferability lies in the relationships among domains, not in copying India's programme arrangements without attention to context.

Limitations and Validation

This article is based on literature and public documents, not observations, interviews, learner data, or independent programme evaluation. The cases are purposive and illustrative; they cannot support claims about comparative effectiveness, causality, or national representativeness. Several constructs—agency, resilience, action competence, and whole-school integration—also require locally valid indicators. A staged research agenda should therefore begin with expert and practitioner review of the framework; proceed to co-designed pilots across contrasting states, school types, languages, and climate-risk settings; develop and validate age-appropriate instruments and portfolio rubrics; and examine implementation through mixed methods. Longer-term and comparative studies should test whether changes in knowledge, reasoning, efficacy, participation, and school practice endure and whether benefits are equitably distributed. Programme documents and dashboard metrics should be triangulated with teacher, learner, parent, and community evidence.

Conclusion

India does not lack relevant climate-education assets. It has curricular reform, national digital and multimodal infrastructure, action-oriented school networks, exemplar-school policy, civil-society resources, and scalable environmental engagement. The central problem revealed by the seven cases is that these assets operate as a distributed collection rather than a deliberately aligned learning system. The CL-ODDE Framework responds by connecting curriculum progression, multimodal access, digitally enriched pedagogy, teacher competence, learner agency, whole-school practice, and competency-based assessment under cross-cutting principles of equity and contextual relevance. Its central proposition is straightforward: access to climate content becomes climate literacy only when learners encounter coherent progression, skilled mediation, authentic inquiry, reflective action, and credible assessment.

Empirical validation is now needed to determine how this proposition works across India's varied educational and ecological contexts.

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