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# Climate Pioneer School: Strengthening Climate Literacy and Low-Carbon Action in Rural Primary Education

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**ABSTRACT**

**Background:** Climate literacy and actions should be developed from primary-school age, particularly in rural communities where educational and environmental vulnerabilities intersect. This community-service program evaluated the Climate Pioneer School implemented at SDN Kadusewu Kelas Jauh, Rumpin, Bogor, Indonesia, on 20-21 September 2024.

**Aims:** The primary objective of this activity was to strengthen climate literacy and environmental awareness among rural primary school students while encouraging practical pro-environmental behavior.

**Methods:** The intervention combined age-adjusted climate and carbon-footprint lessons, participatory games, tree planting, waste sorting, disaster-risk literacy, a collective environmental pledge, and provision of basic learning and sanitation facilities.

**Result:** The program reached 100 students in grades 1-6 and three teachers, while a descriptive endline survey involved 56 students in grades 3-6. Direct outputs included three symbolic tree plantings, distribution of 50 seedlings, and provision of three segregated waste bins. Aggregated positive responses to the intention to apply learning, material quality, learning media, and teaching methods ranged from 93.75% to 97.62%. In contrast, the recorded knowledge increase was only 0.85%, indicating that positive reactions did not automatically represent cognitive mastery. The discrepancy was interpreted in relation to the two-day duration, heterogeneous age groups, reading ability, and the absence of

standardized age-differentiated pre- and post-tests. The program enhanced student engagement and strengthened students' readiness to adopt environmentally responsible behaviors. The program successfully but sustained outcomes require repeated teacher-led activities, child-friendly assessment, behavior observation, seedling and waste monitoring, and integration into whole-school routines. The core implementation model integrates climate literacy, participatory learning, practical low-carbon actions, and school-based follow-up while allowing adaptation to local needs and capacities.

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## 1. Introduction

Climate change increasingly threatens human well-being, ecosystem integrity, and sustainable development. Each increment of warming intensifies interacting hazards and narrows feasible adaptation options (Intergovernmental Panel on Climate Change, 2023). Children face distinctive risks through heat exposure, hydrometeorological disasters, interrupted schooling, health impacts, and limited capacity to protect themselves. Climate-related disruptions have already affected learning at large scale, particularly in low-income and climate-vulnerable settings (Leal Filho *et al.,* 2023; World Bank, 2024). Climate education should therefore be understood not as an optional addition to science lessons, but as a process that develops knowledge, emotional resilience, informed decision-making, and practical agency.

Schools are strategic settings for this work because they connect curriculum, everyday routines, teacher modelling, environmental management, peer norms, and family engagement. Global reviews show that climate and environmental issues remain unevenly integrated into education systems, while recent guidance calls for age-appropriate, action-oriented, justice-sensitive, and interdisciplinary learning (UNESCO, 2021; UNESCO, 2024). The climate crisis is also a child-rights issue because exposure and adaptive capacity are distributed unequally (UNICEF, 2021). Systematic evidence from primary and lower-secondary education highlights the need to combine scientific accuracy with active pedagogies, local relevance, and opportunities to solve problems (Nepras *et al.,* 2022).

Effective climate change education must attend to both cognition and emotion. Young people may experience worry, sadness, anger, and helplessness when climate information is presented without meaningful pathways for action (Hickman *et al.,* 2021; Rushton *et al.,* 2023). Participatory programs can instead transform concern into constructive engagement when children reflect, collaborate, and carry out locally relevant actions (Trott, 2021; Trott, 2022). Teachers are central to this process, yet climate literacy requires interdisciplinary knowledge and pedagogical preparation that are not always available in conventional teacher education (Leve *et al.,* 2023; Winter *et al.,* 2022).

These needs are particularly important in rural and underserved schools. SDN Kadusewu Kelas Jauh is located in Rumpin District, Bogor Regency, in a hilly area with steep and rocky access roads. The school serves approximately 100 students in grades 1-6 with only three teachers. Learning rooms, desks, chairs, boards, stationery, and sanitation facilities are limited. The surrounding area also experiences deforestation, dry and dusty conditions, elevated heat, and landslide risk during heavy rainfall. These conditions connect educational deprivation with environmental and disaster vulnerability. Indonesia's Enhanced Nationally Determined Contribution emphasizes mitigation and adaptation, while school-based disaster-risk reduction still faces institutional, capacity, and scaling challenges (Ministry of Environment and Forestry of the Republic of Indonesia, 2022; Amri *et al.,* 2022). Inclusive and culturally

contextualized disaster education is particularly important in Indonesia's diverse school settings (Sheehy *et al.,* 2024; Suarmika *et al.,* 2022).

In response, the Generasi Cerdas Iklim (GCI) Foundation and Universitas Islam Indonesia, supported through the corporate social responsibility program of PT Arthaasia Finance (AAF), developed the Climate Pioneer School under the theme "Toward a Low-Carbon and Climate-Resilient Model School." The program integrated climate and carbon-footprint literacy, participatory learning, tree planting, waste sorting, basic disaster preparedness, a Climate-Smart Child Pledge, and facility support. Its practical novelty lies in combining climate knowledge, low-carbon actions, and disaster resilience within a single package tailored to a remote primary school. This article aims to describe the implementation process, assess outputs and participant responses, interpret the gap between satisfaction and recorded learning, and formulate a sustainability and replication model.

## 2. Methods

### 2.1 Program Design, Location, and Participants

The community-service activity applied a participatory, experiential, and action-oriented educational design. Students were encouraged to connect new knowledge with local conditions, practice feasible actions, reflect on their meaning, and make a collective commitment. This approach is supported by recent evidence showing that environmental education can improve knowledge, attitudes, intentions, and behavior, although effects vary considerably across settings and evaluation designs (van de Wetering *et al.,* 2022). Culturally relevant and engaging strategies are especially important for rural and underserved learners (Gutierrez *et al.,* 2022), while transformative sustainability education requires classroom practices that link reflection with action (Walshe & Sund, 2022).

The program was conducted on 20-21 September 2024 at SDN Kadusewu Kelas Jauh, Rumpin District, Bogor Regency. The primary participants were 100 students in grades 1-6 and three accompanying teachers. The students were enrolled in primary education, while the teachers had general classroom teaching experience; however, neither group had previously received structured education, training, or practical experience specifically related to climate change adaptation. Representatives of PT AAF, GCI Foundation, and Universitas Islam Indonesia contributed to program opening, facilitation, environmental action, evaluation, and reflection. The perception survey was limited to 56 students in grades 3-6, consisting of 27 boys (48%) and 29 girls (52%), because these grades were considered more able to read and interpret the questionnaire independently.

**Table 1.** Program location, participants, interventions, and direct outputs.

| Component | Description |
|---|---|
| Location | SDN Kadusewu Kelas Jauh, Rumpin District, Bogor Regency, Indonesia |
| Implementation | 20-21 September 2024 |
| Primary participants | 100 students in grades 1-6 and three teachers |
| Survey respondents | 56 students in grades 3-6: 27 boys (48%) and 29 girls (52%) |
| Implementers and partners | GCI Foundation, Universitas Islam Indonesia, PT AAF, and the partner school |
| Main interventions | Climate and carbon-footprint literacy, tree planting, waste sorting, disaster literacy, pledge, facility support, and evaluation |
| Direct physical outputs | Three symbolic tree plantings, 50 seedlings distributed, three segregated bins, and learning/sanitation supplies |

### 2.2 Materials, Instruments, and Data Sources

Materials included climate-change and carbon-footprint visuals, teaching aids, participatory games, activity sheets, colored paper for a "dream tree," a portable sound system, seedlings, planting media, gardening tools, gloves, segregated waste bins, reusable drinking bottles, notebooks, stationery, and sanitation equipment. Content was translated into familiar examples: switching off unused lights,

carrying reusable bottles, avoiding open waste burning, planting and caring for trees, distinguishing organic and inorganic waste, and following teachers' instructions during intense rainfall or signs of landslide danger. Visual and generative learning resources can improve recall and transfer when aligned with children's cognitive levels (Viteri & Pazmiño, 2024), while observation-based activities can make climate processes more tangible (Asimakopoulou *et al.,* 2023).

The endline questionnaire used four response categories, strongly agree, agree, disagree, and strongly disagree, to examine four constructs: intention to apply learning, acceptance of the learning materials, support provided by learning media, and acceptance of teaching methods. Participant observation, facilitator notes, photographs and videos, and an indicator matrix were used as complementary evidence. The survey percentages reported in the activity report were aggregated across multiple items within each construct; consequently, decimal percentages should not be directly converted into student counts for a single question.

**Table 2.** Evaluation framework and verification sources.

| Dimension | Indicator | Data source | Timing | Main limitation |
|---|---|---|---|---|
| Reach | Students, teachers, grades, and partners involved | Attendance and documentation | During program | Does not measure participation intensity |
| Participant reaction | Acceptance of materials, media, and methods | Four-category questionnaire | End of program | Self-report and possible enjoyment bias |
| Learning | Basic climate knowledge and local action understanding | Indicator matrix, questions, observation | Before/during/after | Knowledge instrument was not standardized by age |
| Action intention | Willingness to apply learning and invite others | Questionnaire and pledge | End of program | Intention is not equivalent to behavior |
| Actions and facilities | Planting, seedlings, sorting, and facility support | Documentation and handover records | During/after program | No completed long-term monitoring |
| Sustainability | Seedling care, sorting routines, curriculum integration, replication | Teacher checklist and monitoring | 1, 3, 6, 12 months | Requires school ownership and partner resources |

### 2.3 Implementation Stages

The program followed nine interconnected stages, from needs assessment and collaborative planning to participatory climate education, environmental action, disaster literacy, evaluation, and follow-up planning. A detailed sequence of these stages is presented in the program flowchart.

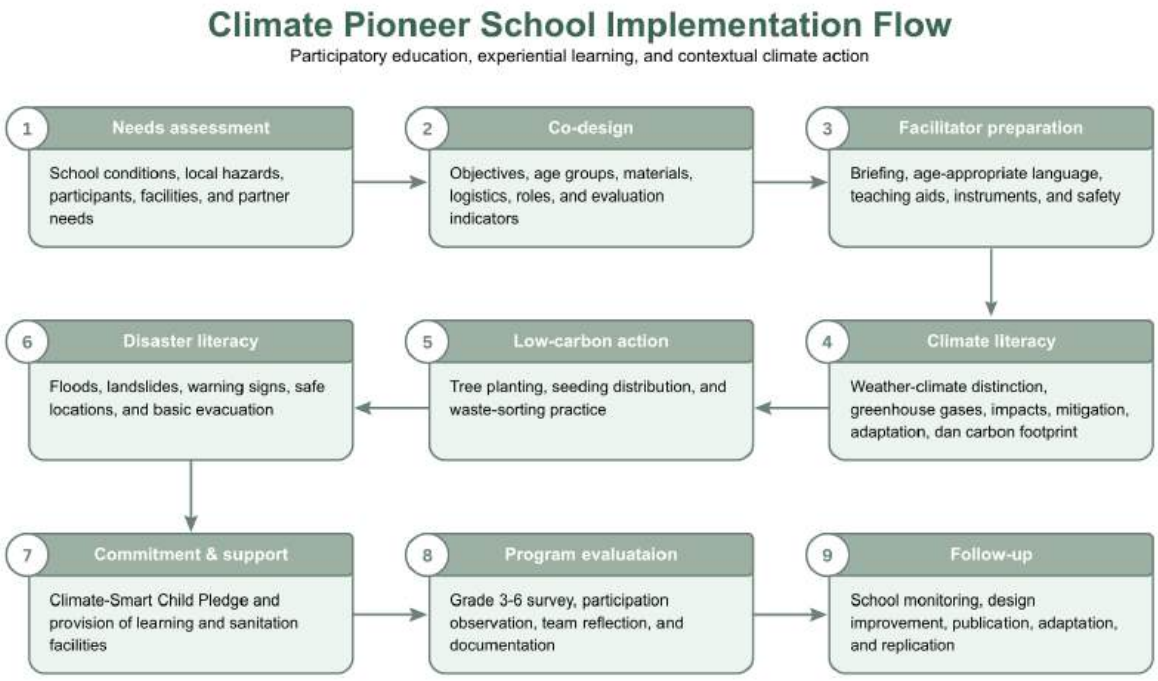


**Figure 1.** *Detailed implementation flow of the Climate Pioneer School program. Evaluation data were generated primarily in Stage 8 through the student survey, participation observation, team reflection, and documentation.*

### 2.4 Data Analysis

Questionnaire responses were analyzed descriptively as percentages within each response category, and positive responses were calculated by combining "strongly agree" and "agree." Program outputs were summarized from attendance records, handover documents, field observations, and photographs. Triangulation was undertaken jointly by the designated GCI and Universitas Islam Indonesia implementation–evaluation team, who compared participant responses, observed participation, the reported knowledge indicator, and available documentary evidence. When discrepancies occurred, direct administrative records were prioritized for participant numbers and physical outputs, while questionnaire data were treated as perceptions rather than evidence of actual behavioral change; findings unsupported by observation or follow-up data were interpreted conservatively. Predefined interpretation criteria included the positive-response calculation, confirmation of outputs through documentary evidence, and separation of participant reaction, learning, action, and longer-term outcomes. No inferential test was applied because the dataset was aggregated and the evaluation was designed as a program assessment rather than a controlled experiment. This distinction is important because informed decisions and conceptual mastery require age-appropriate and psychometrically defensible assessment (Kurup *et al.*, 2021).

## 3. Results and Discussion

### 3.1 Partner Context and Relevance of the Intervention

The partner school combines restricted access, limited staffing, heterogeneous classrooms, inadequate facilities, environmental degradation, and landslide exposure. With only three teachers serving six grade levels, teaching must accommodate wide differences in reading ability, attention span, and prior knowledge. The learning environment therefore required an intervention that was concise, flexible, visually supported, and feasible without increasing teachers' administrative burden. The program also had to reduce material barriers because knowledge about waste sorting or hygiene cannot become routine when basic facilities are absent.


**Figure 2.** *Partner-school identity and the learning environment at SDN Kadusewu Kelas Jauh (team documentation, 2024).*

These conditions matter because climate vulnerability and educational disadvantage can reinforce one another. A school with limited staff and facilities has less time to translate climate policy into classroom practice, while heat, dust, heavy rainfall, and disrupted access can further reduce learning time. The program addressed a narrow but practical part of this problem by bringing age-appropriate materials, facilitators, and basic environmental facilities directly to the school. It did not resolve the school's structural constraints, and the results should not be interpreted as evidence that a short outreach activity can substitute for sustained investment in rural education and climate-resilient infrastructure (Leal Filho *et al.,* 2023; World Bank, 2024).

The remote setting also changed what counted as a workable design. Sessions had to be portable, visually clear, and flexible enough to run across different spaces and age groups. The involvement of teachers throughout the activities was therefore important. Continuity depends less on the visiting team than on whether school staff can reuse the concepts and materials in ordinary lessons without adding an unrealistic reporting burden. Research with underserved learners and teachers similarly highlights the value of locally relevant examples, practical resources, and support for those who will continue the learning after an external program ends (Gutierrez *et al.,* 2022; Leve *et al.,* 2023).

A context-sensitive design helped students recognize climate change as connected to heat, rainfall, vegetation, waste, water, and hazards around them rather than as a distant global issue. Comparative research with primary students shows that children's climate explanations are shaped by social and geographical contexts and may include misconceptions about causes, consequences, and solutions (Sjöblom *et al.,* 2022). The program therefore used local examples while maintaining a distinction between daily weather, longer-term climate patterns, mitigation, and adaptation.

The response matrix in Table 3 shows that each learning topic had an enabling-condition counterpart. Tree planting required caretakers; waste sorting required bins and a workable downstream arrangement; disaster literacy required routes and drills; and the student pledge required adult modelling. This pairing between educational content and school conditions is one of the program's strongest practical features. It recognizes that children cannot maintain a new practice when the surrounding system makes that practice difficult or invisible.

**Table 3.** Partner problems, program responses, and development implications.

| Partner problem | Field evidence | Program response | Development implication |
|---|---|---|---|
| Limited access and services | Remote location, steep road, three teachers for about 100 students | Program delivered directly at school and included all grades | Mentoring must remain flexible and low-burden for teachers |

| Partner problem | Field evidence | Program response | Development implication |
|---|---|---|---|
| Heterogeneous learners | Grades 1-6 differ in reading and attention | Simple language, stories, games, demonstrations, grouped activities | Replication modules should distinguish lower and upper grades |
| Limited facilities | Insufficient stationery, sanitation, and sorting facilities | Learning supplies, sanitation equipment, and waste bins provided | Education should be paired with minimum enabling facilities |
| Environmental degradation | Deforestation, dry/dusty conditions, increased heat | Symbolic planting and distribution of 50 seedlings | Success must be measured through survival and care, not distribution alone |
| Disaster risk | Hilly terrain and landslide risk during heavy rain | Warning signs, safe locations, and basic evacuation introduced | A school risk map, assembly point, and drills are needed |
| No structured climate routine | Environmental activities were not institutionalized | Pledge, interactive learning, and follow-up plan | A lead teacher, student team, routine agenda, and monitoring are required |

### 3.2 Climate Literacy and Participatory Learning

All students joined climate-literacy sessions, with delivery adjusted informally by age. Facilitators explained the difference between weather and climate, links between human activity and greenhouse gases, changing temperature and rainfall, and consequences for everyday life. Stories, prompting questions, demonstrations, games, and teaching aids reduced dependence on technical terminology and invited students to connect information with personal experience. Recent reviews of school climate-and-health education similarly emphasize standardized core concepts, age-appropriate resources, and explicit evaluation of learning (Ramadani *et al.,* 2023).

Program documentation indicated that participation was most visible when students were asked to handle objects, respond to prompts, move, sort, or contribute a written or drawn idea. The "dream tree" activity offered a quieter form of participation alongside group games and oral discussion. These varied modes mattered in a mixed-age setting, where confident speakers, emerging readers, and younger pupils did not participate in the same way. The program therefore created several entry points into the topic, although participation was not recorded systematically by grade, activity, or level of engagement.

The sessions balanced risks with feasible action. Children discussed electricity saving, reusable products, waste sorting, and tree care. This approach sought to build efficacy without presenting children as primarily responsible for resolving a structural crisis. Climate education that focuses only on threats can intensify existential concern, whereas learning that includes dialogue, collective action, and realistic hope can support constructive engagement (Trott, 2022; Vandenplas *et al.,* 2023). Learning resources also need to avoid reducing sustainability to consumer choice alone and should clarify institutional and collective responsibility (Wheeler, 2023).

The program's high levels of enjoyment are consistent with evidence that empirical and playful science activities can generate motivation and improve climate understanding (Kumar *et al.,* 2023). Nevertheless, enjoyment is a condition for engagement rather than a complete measure of learning. Climate literacy includes scientific knowledge, critical thinking, values, emotions, and decision-making; each component requires specific assessment.

Another result was the presentation of climate action as a shared social practice rather than a private duty. Students saw teachers, facilitators, foundation staff, and the corporate partner take part in the same learning and planting activities. That visible collaboration can strengthen social norms and a sense of collective efficacy. It can also create a less desirable association between environmental action and special events or outside visitors. Regular teacher-led follow-up is therefore needed to move the message from event-based enthusiasm into an ordinary part of school life (Trott, 2021; Walshe & Sund, 2022).

### 3.3 Tree Planting and Waste-Sorting Actions

Tree planting combined a symbolic partnership moment with student participation. Three trees were planted in the school yard by representatives of PT AAF, the GCI Foundation, and the school. Fifty additional seedlings were distributed for planting at school or at students' homes. The activity introduced vegetation functions related to shade, soil protection, habitat, carbon uptake, and responsibility for care. Experiences such as school gardens can reshape children's environmental conceptions when participation is sustained and connected with reflection (Petrou & Korfiatis, 2022). However, distributed seedlings cannot yet be reported as ecological impact because species, location, survival, growth, and maintenance data were not available in the manuscript dataset.

The distribution of 50 seedlings broadened participation beyond the three ceremonial plantings, but it also dispersed responsibility. Seedlings taken home may encourage family conversation and care, whereas seedlings kept at school are easier to monitor collectively. Because the available report did not record final planting locations, the program cannot compare these pathways. A simple seedling register containing species, recipient, location, planting date, caretaker, and condition would turn a symbolic output into a trackable learning and environmental result.

During the waste session, students identified organic and inorganic materials and placed examples in the appropriate container. Three segregated bins were handed over to the school. The practice demonstrated that waste management involves daily decisions and enabling infrastructure. Long-term performance will depend on clear labels, convenient placement, student duty schedules, teacher feedback, and a connection to local collection or treatment arrangements. Without these supporting conditions, segregation may stop after the initial event.


**Figure 3.** *Student participation in tree planting and waste-sorting practice (team documentation, 2024).*

The waste activity exposed a similar distinction between knowing and systems. Students could demonstrate the categories during the session, yet sustained segregation depends on what happens after materials enter the bins. If separated waste is later mixed, the educational message loses credibility. Future cycles should include a short mapping of local waste handling, agreement on bin responsibility, and periodic visual audits. This would allow the school to discuss contamination and practical barriers instead of treating sorting as a one-time demonstration. Such reflection is consistent with transformative sustainability education, which connects classroom activity with the systems that shape everyday choices (Walshe & Sund, 2022).

**Table 4.** Activities, observed outputs, learning meaning, and follow-up needs.

| Activity | Observed output | Learning meaning | Follow-up need |
|---|---|---|---|
| Climate and carbon-footprint literacy | Interactive classes for 100 students with three teachers | Causes, impacts, mitigation, adaptation, and daily actions | Age-differentiated modules, repetition, and knowledge assessment |
| Tree planting | Three symbolic plantings and 50 seedlings distributed | Greening, responsibility, and nature connection | Species/location records, caretakers, and survival monitoring |
| Waste sorting | Student practice and three segregated bins | Classification skills and routine formation | Duty roster, waste audit, labels, and downstream handling |
| Disaster literacy | Flood/landslide risks, warning signs, safe locations, evacuation | Risk awareness and basic safety response | Risk map, assembly point, evacuation route, and drills |
| Climate-Smart Child Pledge | Collective commitment by students | Identity, social norms, and action intention | Visual reminders, class reflection, and adult modelling |
| Facility support | Books, stationery, reusable bottles, sanitation equipment | Reduced material barriers to practice | Inventory, maintenance, and shared responsibility |
| Documentation and communication | Photo album, pre/post video, social media, local media coverage | Message reach and partnership accountability | Child safeguarding and proportionate impact claims |

### 3.4 Disaster Literacy, Student Commitment, and Facility Support

Disaster literacy focused on floods and landslides relevant to the hilly landscape of Rumpin. Students were introduced to rainfall and soil conditions, avoiding slopes or water flows when conditions deteriorate, identifying a safe gathering place, and following teachers or adults. This session should be understood as introductory awareness rather than a substitute for a school risk assessment or evacuation drill. Indonesian evaluation research shows that school disaster-risk reduction becomes more sustainable when it is integrated into school routines and linked with families and communities (Amri *et al.,* 2022). Indigenous and locally grounded knowledge can also make disaster learning meaningful to primary-school students (Suarmika *et al.,* 2022), while inclusive design is needed to ensure accessibility for all children (Sheehy *et al.,* 2024).

The session also clarified the boundary between risk awareness and operational preparedness. Recognizing a warning sign is useful, but readiness requires a known assembly point, an accessible route, clear teacher roles, and repeated practice. In a school with only three teachers, emergency procedures must remain simple and workable during multi-grade supervision. The next stage should therefore be a school-led risk walk, a basic hazard map, and a short drill designed with local authorities or disaster-management actors (Amri *et al.,* 2022; Sheehy *et al.,* 2024).

At the end of the program, students recited the Climate-Smart Child Pledge, promising to maintain cleanliness, practice environmentally responsible actions, and invite friends and family to participate. The pledge is not evidence of behavioral change, but it can help establish collective identity and social norms when supported by visible reminders, repeated practice, adult examples, and feedback. The provision of notebooks, stationery, reusable bottles, sanitation materials, and waste-sorting facilities reduced practical barriers and strengthened the likelihood that some actions could continue after the external team left.

**Figure 4.** *Interactive climate learning, disaster literacy, the student pledge, and facility support (team documentation, 2024).*

The facility support had a dual function. It responded to immediate learning and sanitation needs, while also making the environmental messages more credible by giving students materials they could use. At the same time, donated items require an ownership plan. Assigning storage, maintenance, replacement, and daily-use responsibilities would help ensure that reusable bottles, bins, learning media, and cleaning equipment remain part of school routines rather than becoming remnants of a single event.

### 3.5 Survey Results and Interpretation of Learning

The endline evaluation involved 56 students in grades 3-6. For intention to apply learning, 80.95% of aggregated responses were "strongly agree" and 16.07% were "agree," producing 97.02% positive responses. Positive responses were 93.75% for understandable and interesting materials, 97.62% for the contribution of learning media, and 96.43% for enjoyable teaching methods. These findings show that the intervention was well received and created an engaging learning experience. The comparatively lower result for materials suggests that content differentiation by age and reading ability requires further improvement.

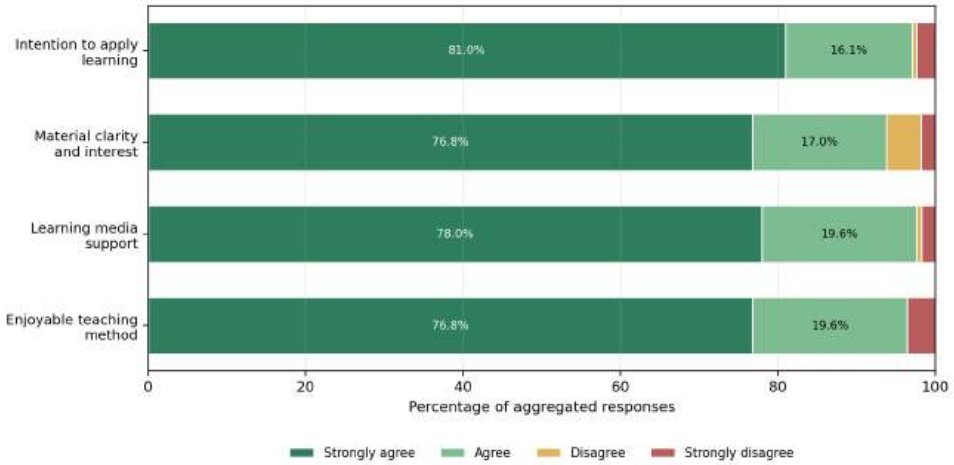


**Figure 5.** *Aggregated participant responses for learning materials, media, methods, and intention to apply knowledge (n = 56).*

**Table 5.** Survey outcomes and program interpretation.

| Dimension | Strongly agree (%) | Agree (%) | Disagree (%) | Strongly disagree (%) | Positive (%) | Interpretation |
|---|---|---|---|---|---|---|
| Intention to apply learning | 80.95 | 16.07 | 0.60 | 2.38 | 97.02 | Strong initial readiness; verify with observed practice after 1-3 months |
| Materials clear and interesting | 76.79 | 16.96 | 4.46 | 1.79 | 93.75 | Lowest positive score; differentiate materials for lower and upper grades |
| Media supported understanding | 77.98 | 19.64 | 0.60 | 1.79 | 97.62 | Teaching aids were well received; retain and provide a teacher guide |
| Teaching methods were enjoyable | 76.79 | 19.64 | 0.00 | 3.57 | 96.43 | Positive interaction; explore negative responses qualitatively by age group |

The survey covered 56% of all student participants and intentionally focused on grades 3-6 because the questionnaire required more independent reading. The respondent group was nearly balanced by sex, consisting of 27 boys and 29 girls. However, the available dataset did not provide item-level or subgroup responses, so the analysis could not examine differences by grade, sex, reading ability, or previous exposure to environmental topics. The findings describe the responding group as a whole and should not be generalized beyond the participating school.

Across the four constructs, the positive-response range was narrow, from 93.75% to 97.62%, while the "strongly agree" share ranged from 76.79% to 80.95%. This consistency suggests broad acceptance rather than one unusually popular component. The learning-material score was the lowest and the media score was the highest. One plausible interpretation is that visual and hands-on elements helped students engage with content that remained demanding for some readers. That interpretation is consistent with the program observations, but it cannot be confirmed without item-level data, interviews, or grade-specific analysis.

High participant satisfaction should not be equated with conceptual mastery or actual behavior. The activity report recorded a knowledge increase of only 0.85%, substantially below the planned 25% target. The contrast between positive reactions and minimal measured knowledge gain may reflect the short two-day duration, mixed grade levels, reading differences, item difficulty, limited response time, and the absence of standardized age-specific pre- and post-tests. Meta-analytic evidence confirms that environmental education can improve multiple outcomes, but it also identifies substantial heterogeneity and methodological weaknesses in evaluation (van de Wetering *et al.*, 2022).

The available evidence should therefore be interpreted by outcome level. First, reach was high because the program included the whole school community. Second, reaction was strongly positive. Third, observation and documentation showed active participation in planting, sorting, discussion, and the pledge. Fourth, the cognitive indicator remained weak. Fifth, no longitudinal evidence was available for behavior, seedling survival, waste quality, or intergenerational influence. This separation prevents overclaiming and supports a more rigorous follow-up design. Future assessment should use brief parallel pre/post items differentiated for lower and upper grades, picture-based questions for emerging readers, behavior checklists, waste audits, seedling records, teacher interviews, and measurements at 1, 3, 6, and 12 months.

Because the questionnaire was administered at the end of a highly visible partner-supported event, some responses may also have been influenced by courtesy, facilitator presence, or the excitement of receiving new materials. This does not make the findings unusable; it clarifies what they measure. They

are strongest as evidence of acceptability and immediate motivation. They are much weaker as evidence of retained knowledge, independent decision-making, or behavior outside the activity.

Future evaluation should preserve the simplicity required in a rural primary school while improving validity. Two short grade-banded instruments could combine picture-based questions, scenario choices, and one open response. The same items should be used before the first session and after a suitable interval, rather than only at the end of the event. A small number of teacher observations, such as correct waste disposal, care for seedlings, and routine use of reusable bottles, would add behavioral evidence without creating an excessive reporting burden. This approach would better reflect recommendations to measure multiple environmental-education outcomes while keeping assessment appropriate to children and local capacity (Nepraš *et al.,* 2022; van de Wetering *et al.,* 2022).

### 3.6 Program Sustainability and Replication Potential

Sustainability requires a transition from a two-day event to a school-owned learning cycle. The principal, a designated lead teacher, and a student team should establish simple routines, define responsibilities, and monitor a small set of indicators. Whole-school sustainability is strengthened when leadership, curriculum, school operations, student participation, and community relationships are aligned (Seiser *et al.,* 2023). External partners should therefore support institutional capacity and monitoring rather than creating dependence on repeated ceremonial events.

School ownership should be visible in ordinary decisions: who waters each seedling, who checks the bins, when a five-minute climate reminder is delivered, and how problems are discussed. These small arrangements are more important for continuity than adding many new activities. The design should also recognize teacher workload. A single-page monthly checklist and a few photographs of agreed indicators are more likely to be maintained than a complex reporting platform.

During the first three months, the school should appoint a lead teacher and student team, inventory facilities, label seedlings, assign caretakers, and establish waste-sorting duties. Months 4-6 should integrate follow-up activities into science, thematic projects, sanitation duties, and simple waste audits. Months 7-9 should include student-teacher reflection and communication with families. Months 10-12 should culminate in an annual evaluation and documentation of lessons. Physical visits are not required for every monitoring point; short forms, photographs, virtual meetings, and teacher messaging can maintain continuity.

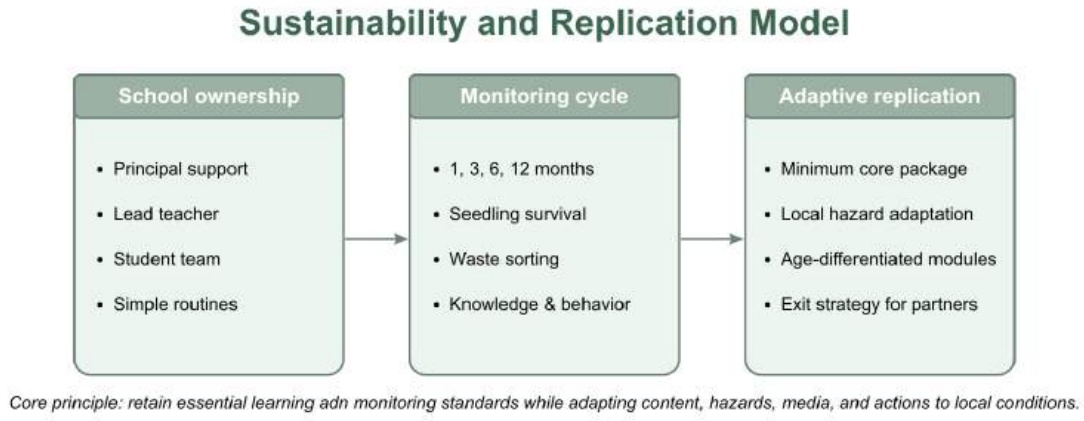


**Figure 6.** *Proposed sustainability and adaptive-replication model for the Climate Pioneer School.*

Family involvement can extend the program beyond school, especially for seedlings taken home and household waste practices. However, family participation should be invited rather than assumed. Short take-home prompts, student stories, or a community display can open conversation without shifting responsibility to families that may have limited time or resources. Where feasible, village

representatives, local government, or waste-service actors can join the annual review so that school routines connect with services outside the school gate.

**Table 6.** Twelve-month sustainability roadmap.

| Period | Main agenda | Responsible actors | Minimum indicators | Key risk and mitigation |
|---|---|---|---|---|
| 0-1 month | Appoint lead teacher/student team; inventory assets; map seedlings and bins | Principal and teachers | Team and asset list; location and caretaker for each seedling | Unclear roles: use a simple assignment letter and weekly checklist |
| 2-3 months | Seedling care, sorting duties, short reinforcement lessons | Teachers and student team | Seedling survival, watering frequency, sorting observations | Dry season/damage/fatigue: rotate duties, repair labels, provide non-material recognition |
| 4-6 months | Integrate activities into learning and conduct a simple waste audit | Class teachers and GCI | At least two follow-up lessons and one waste audit | Curriculum burden: use short modules linked to science/thematic learning |
| 7-9 months | Student-teacher reflection and family communication | School, GCI, parent representatives | Reflection forum and agreed action points | Low family participation: use regular school events and simple home practices |
| 10-12 months | Annual evaluation, documentation, and replication decision | School, GCI, UII, PT AAF | Brief report on learning, behavior, seedlings, waste, and lessons | Inconsistent data: use concise instruments and sample verification |

Replication should follow a "minimum standard with local adaptation" principle. The minimum package includes a school needs assessment, core climate lesson, one monitorable environmental action, local risk literacy, a lead teacher, an evaluation instrument, and a monitoring plan. Adaptation should address local hazards, language, age distribution, available media, appropriate vegetation, waste systems, and community culture. An enhanced package may add school gardens, composting, simple carbon or energy audits, weather observation, peer education, family projects, or interschool networks. Replication is therefore not the identical reproduction of activities, but preservation of core learning and accountability standards while modifying delivery to fit context.

Replication also requires attention to facilitation quality. A larger rollout should not simply multiply participant numbers. It should prepare facilitators to work with mixed-age groups, use local examples accurately, manage child safeguarding, and distinguish between climate mitigation, adaptation, and disaster risk reduction. A short facilitator guide, a demonstration session, and a structured post-activity reflection would improve consistency while preserving room for local adaptation (UNESCO, 2024; Viteri & Pazmiño, 2024).

**Table 7.** Replication packages and readiness indicators.

| Component | Minimum package | Local adaptation | Enhanced package | Readiness indicator |
|---|---|---|---|---|
| Governance | Needs assessment, lead teacher, school approval | Local-risk and stakeholder mapping | Cross-school/community team and annual plan | Principal support, lead teacher, and scheduled time |
| Learning | Basic climate literacy and daily actions | Age, language, and hazard differentiation | Thematic projects, measurements, peer education | Age-appropriate material and sufficient facilitators |
| Environmental action | One monitorable action | Vegetation, water, energy, or waste selected locally | Garden, compost, audits, or weather monitoring | Facility, location, caretaker, and maintenance plan |

| Component | Minimum package | Local adaptation | Enhanced package | Readiness indicator |
|---|---|---|---|---|
| Disaster resilience | Hazard awareness and basic response | Focus on locally dominant hazard | Risk map, evacuation route, drills, agency coordination | Priority hazard and basic procedure identified |
| Evaluation | Reaction survey and documentation | Age-differentiated pre/post and behavior checklist | 1-12 month monitoring and environmental audit | Baseline, schedule, instrument, and data owner |
| Partnership | Logistics and facilitation | Co-design with community/local government | Multi-year financing and learning network | Roles, ethics, safeguarding, and partner exit plan agreed |

Corporate, civil-society, university, government, and school collaboration can accelerate replication, but ownership should remain with the school community. Communication through photography, video, social media, and local media can increase accountability and public learning, provided that child protection, informed permission, privacy, and proportionate impact claims are maintained. The program's contribution to climate action lies not only in individual behavior messages but also in creating an institutional space where students, teachers, families, and partners share responsibility.

### 3.7 Cross-Cutting Outcomes, Implementation Lessons, and Limitations

Taken together, the results point to a program that was strongest as an activation and enabling intervention. It reached the whole school, created an enjoyable entry point to climate issues, provided concrete facilities, and produced visible actions. The evidence is less developed for knowledge gain, habit formation, ecological outcomes, or institutionalization. This distinction matters because community-service programs are often judged through attendance and satisfaction alone. Here, the contrast between high acceptance and the reported 0.85% knowledge increase provides a useful warning against equating enthusiasm with learning.

The multi-grade format was both a strength and a constraint. Whole-school participation supported a shared identity and allowed younger children to observe older peers. At the same time, one delivery sequence could not fully match six grade levels. The most practical improvement is not a separate program for every grade, but two learning bands, grades 1-3 and grades 4-6, with different vocabulary, session length, media, facilitator ratios, and assessment methods.

The study also has clear limitations. It was conducted at one school without a comparison group. Survey respondents came from the older grades, the data were aggregated, and no item-level dataset was available for reliability testing or subgroup analysis. Observations and photographs confirm that activities took place and students participated, but they do not demonstrate retention or behavior change. Ecological outcomes were not measured, and no post-program monitoring data were available when the manuscript was prepared.

These limitations do not diminish the value of the activity; they define the claims that can responsibly be made. The program offers a credible, context-responsive starting model for climate and disaster learning in a resource-constrained rural school. Its next contribution should be methodological: a light but more rigorous monitoring system that follows a small number of students, actions, and school routines over time.

**Table 8.** Cross-cutting lessons and priority improvements for the next program cycle.

| Implementation issue | Evidence from this program | Interpretation | Priority improvement | Suggested indicator |
|---|---|---|---|---|
| Mixed-age participation | 100 students in grades 1-6; survey limited to 56 students in grades 3-6 | Whole-school inclusion supported shared identity, but reading ability and attention differed widely | Use two grade bands with differentiated language, pacing, media, and facilitator ratios | Completion and concept accuracy by grade band |
| Reaction versus learning | Positive responses ranged from 93.75% to 97.62%; reported knowledge increase was 0.85% | The program was engaging, but cognitive gain was not demonstrated by the available measure | Use parallel, child-friendly pre/post items and delayed follow-up | Adjusted knowledge gain and retention after 1-3 months |
| Action versus sustained practice | Three symbolic trees, 50 distributed seedlings, three bins, and a collective pledge | Immediate participation was visible; continuation and environmental effects remain unknown | Assign caretakers, keep simple logs, and conduct waste and seedling checks | Seedling survival and correct sorting rate |
| School capacity and ownership | Three teachers, remote access, limited facilities, and external facilitation | The intervention must remain low-burden and transfer responsibility to the school | Appoint a lead teacher and student team; use a one-page monthly checklist | Checklist completion, routine meetings, and documented follow-up |
| Evidence quality | Single-site descriptive design, endline self-report, aggregated data, and no longitudinal monitoring | Findings are context-specific and strongest for reach, acceptability, and immediate participation | Collect baseline, qualitative feedback, and follow-up data at 1, 3, 6, and 12 months | Retention, behavior, ecological condition, and documented adaptations |

Table 8 translates the main lessons into a practical improvement agenda. The emphasis is on a small set of repeatable measures rather than a large evaluation burden. This direction is consistent with recent calls for climate education that is locally relevant, action-oriented, emotionally supportive, and embedded in whole-school practice (Seiser *et al.,* 2023; UNESCO, 2024; Walshe & Sund, 2022).

## 4. Conclusions

The Climate Pioneer School reached 100 students and three teachers by integrating climate literacy, tree planting, waste sorting, disaster preparedness, student commitment, and facility support. It produced three symbolic tree plantings, distributed 50 seedlings, provided three segregated waste bins and basic school supplies, and obtained 93.75-97.62% positive responses for learning materials, media, methods, and intention to apply knowledge. However, the reported 0.85% knowledge increase demonstrates that strong satisfaction cannot by itself substantiate cognitive learning or behavioral change.

The Climate Pioneer School engaged 100 students and three teachers through an integrated model combining climate literacy, tree planting, waste sorting, disaster preparedness, student commitment, and facility support. The program resulted in three symbolic tree plantings, the distribution of 50 seedlings, the provision of three segregated waste bins and basic school supplies, and positive participant responses ranging from 93.75% to 97.62% for the learning materials, media, methods, and intention to apply the knowledge gained. Its main contribution to community-service practice lies in demonstrating how climate education in a resource-constrained rural school can move beyond classroom instruction by linking knowledge, practical action, risk preparedness, and enabling facilities within a single context-sensitive intervention. However, the reported knowledge increase of only 0.85% indicates that high satisfaction and participation cannot independently confirm cognitive learning or sustained behavioral change.

These findings suggest that future implementation should retain the integrated model while strengthening its educational and monitoring components. The limited knowledge gain supports the use of age-differentiated modules and child-friendly pre- and post-assessments, while the absence of longitudinal evidence highlights the need for teacher-led follow-up, direct observation of environmental practices, and regular monitoring of seedling survival and waste sorting. Meaningful replication should therefore be grounded in school ownership, a designated lead teacher and student team, minimum supporting facilities, adaptation to local climate and disaster risks, and transparent evaluation over an extended period. In this way, the program can develop from a short-term community-service activity into a practical school-based model for sustained climate learning and environmentally responsible behavior in rural primary education.

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## 6. Authors Note

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirm that the manuscript is original and has not been submitted simultaneously to another journal. Photographs are used as program documentation; publication should follow the consent, privacy, and child-safeguarding requirements of the receiving journal.

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