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Crafting change: Empowering Deaf female learners through a hands-on, arts-based climate initiative

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Abstract

Plastic pollution poses an escalating global threat, with projections warning of more plastic than fish in our oceans by 2050. In East Africa, this crisis intersects with deep educational inequities, particularly for learners with disabilities who remain excluded from climate adaptation and education programs. This study addresses this gap by investigating how a hands-on, arts-based climate initiative integrated into the formal curriculum can simultaneously advance environmental literacy, social inclusion, and learner empowerment. Grounded in Education for Sustainable Development (ESD), Human Capital Theory, and the Capability Approach, a three-month intervention engaged 60 deaf female pupils of Grades 4,5, and 6 in Tanzania through the 3Rs framework (Reduce, Reuse, Recycle). Learners participated in modules on plastic pollution, collected waste, upcycled materials into marketable crafts, and led community exhibitions. Qualitative findings from observations, teacher interviews, and learner artefacts revealed promising outcomes: enhanced creativity, confidence, and environmental stewardship, alongside increased visibility and inclusion. The initiative also advanced multiple Sustainable Development Goals (SDGs), including SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities), and SDG 13 (Climate Action). Key challenges included limited instructional time, language barriers in sign-supported sustainability concepts, and market resistance to upcycled products. The study concludes that embedding experiential, arts-based education within inclusive curricula is a powerful strategy for fostering agency and sustainability among marginalized learners. It offers actionable recommendations for educators, curriculum developers, and policymakers to institutionalize

inclusive ESD and build resilient, equitable futures.

Key terms: Inclusive climate education, Art-Based Learning, Education for sustainable development, Plastic pollution.

Introduction

The twenty-first century is marked by an unprecedented convergence of environmental degradation, climate change, and increasing social inequalities, all requiring transformative educational responses. Plastic pollution, a major contributor to the broader climate crisis, has reached alarming levels, with reports projecting that by 2050, there could be more plastic than fish in the world's oceans (UNEP, 2023). The persistence of plastic waste not only endangers marine ecosystems but also leads to soil and air contamination, impacting human health and livelihoods. In East Africa, the problem is worsened by rapid urbanization, weak waste management systems, and limited public awareness about sustainable consumption (Munnelly et al., 2023). Addressing plastic waste is therefore both an environmental necessity and a climate mitigation strategy, with education serving as a crucial tool for building adaptive and resilient communities. Despite increased global discussions on sustainability, climate education in the region remains fragmented, often theoretical, urban-focused, and disconnected from the daily realities of marginalized populations.

Education has long been recognized as a vital instrument for advancing sustainability. The Education for Sustainable Development (ESD) framework, championed by UNESCO, advocates for equipping learners with the knowledge, skills, and values required to act for environmental integrity, economic viability, and social justice (UNESCO, 2020a). Through its focus on critical thinking, participatory learning, and transformative action, ESD offers a pathway for reimagining education as a catalyst for climate resilience and social inclusion. However, in many developing contexts, the implementation of ESD has remained uneven, with a strong emphasis on cognitive outcomes and limited attention to the social and emotional dimensions of learning (Heumann, 2023).

In East Africa, Tanzania included, systemic inequities have further hindered inclusive participation in climate education. Deaf learners, particularly girls, continue to face structural and cultural barriers that restrict their access to meaningful learning opportunities. Studies show that these learners are often excluded from environmental programs due to stigma, limited teacher preparation in sign language, and inadequate adaptation of instructional materials (Asongu et al., 2023). Consequently, the intersection of gender, disability, and environmental marginalization creates a triple disadvantage that undermines both educational and developmental goals.

Addressing these challenges requires educational innovations that bridge environmental and social sustainability through inclusive, experiential, and creative pedagogies. Art-based learning has emerged as a promising approach in this regard, as it fosters hands-on engagement, critical reflection, and emotional expression, particularly for learners with communication barriers (Fajrie et al., 2024; Rege, 2025). Integrating arts with climate education not only nurtures creativity and problem-solving skills but also transforms abstract sustainability concepts into tangible, lived experiences.

This study responds to these educational and social gaps by examining how an arts-based climate initiative, grounded in ESD principles, empowered deaf female pupils in Tanzania to transform plastic waste into marketable crafts while enhancing their environmental literacy and entrepreneurial competencies. The research explores how this hands-on initiative fostered inclusion, agency, and sustainable learning among marginalized learners, thereby demonstrating how inclusive pedagogical models can contribute to climate action and social equity simultaneously.

The study aimed to examine how a hands-on, arts-based climate initiative can enhance environmental

literacy, social inclusion, and learner empowerment among deaf female pupils in a Tanzanian special school setting. Specifically, by examining how a hands-on 3Rs-based intervention enhances deaf female learners' creativity, confidence, and environmental conservation.

This study therefore addresses the following research questions;

1. How does participation in an arts-based recycling initiative influence deaf female pupils' creativity and innovation?
2. In what ways does the hands-on climate initiative foster the deaf female learners' confidence and social inclusion?

Problem Statement

Ideally, Education for Sustainable Development (ESD) and climate education should provide all learners, including those with disabilities, with equitable opportunities to develop the knowledge, skills, values, and agency needed to respond to environmental challenges through participatory and experiential learning (UNESCO, 2020b, 2021). However, existing climate education interventions have predominantly been designed for learners without disabilities, giving limited attention to the participation, accessibility needs, and experiences of learners with disabilities, particularly in East Africa. Deaf female learners may face additional barriers arising from inadequate teacher preparation in sign language and disability-inclusive pedagogy, inaccessible learning materials, and social stigma (Asongu et al., 2023). Although research has demonstrated the potential of ESD and arts-based learning to promote engagement, creativity, and inclusion (Bertling, 2023; Fajrie et al., 2024), limited attention has been given to combining these approaches to support climate education among deaf learners in East African special-school contexts. This leaves a gap in evidence on practical, inclusive approaches that can make climate education accessible and meaningful to deaf learners. Therefore, this study addresses the gap by examining how a hands-on, arts-based participatory climate initiative can support environmental literacy, social inclusion, and learner empowerment among deaf female pupils in Tanzania.

Literature Review

Education for Sustainable Development (ESD) emphasizes transformative learning that integrates cognitive, socio-emotional, and behavioral dimensions (Barr et al., 2025; Phillips & Phillips, 2021; Sterling, 2010). While scholars widely agree that ESD promotes critical thinking and active citizenship, there remains debate over its operationalization in formal education systems. Several studies further highlight its transformative potential but note that implementation often remains confined to theoretical instruction rather than lived experience. Heumann (2023) further argues that ESD's success depends on contextual relevance and participatory practice, yet many school systems, especially in the Global South, still employ traditional, exam-oriented pedagogies that limit learner agency. Together, these studies affirm ESD's value but reveal a persistent disconnect between policy aspiration and practical classroom integration.

Inclusive climate education is increasingly recognized as a justice issue. According to Sandoval Mena and Waitoller (2025), learners with disabilities are frequently excluded from environmental and sustainability programs due to structural inaccessibility and low teacher preparedness. UNESCO (2021) further notes that gender disparities intersect with disability, producing compounded marginalization where girls with disabilities are least likely to access STEM or sustainability learning. However, while these studies underscore exclusion, few have examined innovative pedagogies that can bridge accessibility gaps. This study contributes to extending current understanding by exploring how arts-based, inclusive learning can

operate the ideals of equitable ESD at the classroom level.

Art-based learning, grounded in constructivist and experiential paradigms, has shown promise in fostering creativity, communication, and emotional resilience, especially among deaf learners. (Rege, 2025). Yet, despite growing global evidence of its efficacy, most applications have focused on mainstream or urban settings. Bertling (2023) found that arts-based sustainability projects enhance environmental awareness, but they did not examine inclusivity or disability-sensitive adaptations. The current study extends this conversation by situating art-based climate learning within a marginalized, special-needs context, addressing a rarely explored intersection of art, disability, and environmental education in sub-Saharan Africa.

This research, therefore, contributes new insights into how experiential, creative, and inclusive approaches can translate sustainability ideals into tangible classroom and community practices.

Theoretical Framework

This study is grounded in two theories complementing each other: Human Capital Theory and the Capability Approach.

Human Capital Theory: As articulated by Becker (2009), it conceptualizes education as an investment that enhances individual productivity and social mobility. In this study context, this theory explains how skill-based sustainability programs equip learners with competencies that increase their economic participation and community contribution. However, this theory tends to prioritize economic utility over human diversity, well-being, and intrinsic development. Its emphasis on measurable outcomes overlooks the broader social and emotional dimensions of learning, particularly for marginalized groups whose capabilities extend beyond economic productivity.

Capability Approach: Founded and advanced by Sen (1999) and Nussbaum (2000), shifts the focus from productivity to empowerment, valuing what individuals can do and become. This framework emphasizes expanding people's freedoms and opportunities to lead lives they have reason to value, recognizing that well-being encompasses multiple dimensions beyond economic advancement. Within ESD, this approach provides a more humanistic and inclusive rationale for educational interventions that prioritize learner agency, participation, and dignity.

This study integrates both perspectives to offer a holistic analytical framework, where Human Capital Theory informs the focus on skill development and economic empowerment of the deaf female learners through upcycling and entrepreneurship, while the Capability Approach foregrounds the intrinsic value of expanded freedoms, social inclusion, and learner agency. By combining these lenses, the study situates education not merely as economic preparation but as a transformative process that cultivates equality, sustainability, and human flourishing. This dual theoretical grounding is therefore relevant for understanding how arts-based ESD interventions can address both practical skill development and broader capability expansion among marginalized learners.

Methodology

Research Design

This study adopted a qualitative Participatory Action Research (PAR) design, consistent with ESD's emphasis on transformative, community-based, and learner-centered inquiry. Qualitative approaches were particularly appropriate given the need to capture nuanced, context-specific experiences of deaf learners through observation, visual artifacts, and in-depth teacher interviews. PAR was chosen because it enabled participants to become active contributors in the change process rather than passive subjects (Baum et al., 2006; Whyte et al., 1998). Through this approach, both pupils and teachers collaboratively

engaged in identifying environmental challenges, experimenting with sustainable solutions, and reflecting on the outcomes of their actions.

Learners as Co-Inquirers in the PAR Process

Consistent with PAR principles of Baum et al. (2006), the pupils participated not merely as subjects but as active co-inquirers throughout the research process. Their roles included:

- **Problem identification:** Through guided discussions and visual brainstorming sessions, they identified plastic waste as a pressing environmental issue within their school and community;
- **Decision-making:** Pupils contributed to selecting which types of crafts to produce and how to design them, exercising agency over the creative process;
- **Data generation:** by documenting their experiences through drawings, crafts, and demonstrations, producing visual data that reflected their perspectives and learning;
- **Reflection:** During group sessions, pupils used sign language and gestures to evaluate their work, suggest improvements, and articulate what they had learned;
- **Community engagement:** By leading public exhibitions, pupils acted as advocates for sustainability, sharing their knowledge with broader audiences.

Teacher observations and interviews captured these co-inquiry processes, while visual artifacts and documentation provided direct evidence of pupil participation and agency.

Target Population and Sampling Procedure

The study involved 60 female deaf pupils, 10-16 years of age and enrolled in Grades 4, 5, and 6 at a special school for the deaf in Dar es Salaam, Tanzania. The grades were purposively selected since they had sufficient cognitive development to engage with environmental concepts and creative production. All the pupils had severe to profound hearing loss and communicated primarily through Tanzanian Sign Language.

All 60 pupils across these three grade levels participated in the intervention, as the project was integrated into their regular creative arts curriculum.

Additionally, the choice of an all-female sample was intentional, since girls with disabilities face compounded marginalization in educational and environmental contexts (UNESCO, 2021), and the study specifically aimed to explore empowerment pathways for this doubly disadvantaged group.

Figure 1: *The 3R Sustainability Framework used for the Initiative*



Data Collection Methods and Procedures

Given the learners' communication needs, data collection relied on qualitative and participatory techniques that emphasized observation and collaboration.

Classroom observations were conducted weekly throughout the project to document behavioural and attitudinal changes in students' engagement, teamwork, and creativity. Observation checklists and field notes recorded non-verbal expressions, participation levels, and interaction patterns. Interviews with creative arts teachers were held to gain insights into learners' progress, their experiences of inclusion, and the perceived impact of the intervention. Visual documentation and artifacts, such as students' artwork, gestures, and visual expressions, served as reflective data. Their crafted items, photos of group activities, and demonstrations during exhibitions provided tangible evidence of learning and growth.

Triangulation across these sources enhanced the credibility and trustworthiness of findings and further provided a comprehensive understanding of the social Action impact. (Poth, 2018).

Communication Protocol and Language Access

For meaningful data collection, the following measures were implemented:

- All sessions were conducted with the support of qualified sign language interpreters proficient in Tanzanian Sign Language;
- Classroom teachers, who possess established relationships with the pupils and fluency in sign language, co-facilitated sessions and assisted with interpretation;
- Visual aids, diagrams, and written materials were used alongside sign-supported explanations to reinforce understanding of environmental concepts;
- Pupils communicated their experiences through multiple modalities including sign language, gestures, drawings, and crafted artifacts, ensuring that language barriers did not limit expression;
- Teacher interviews explored not only observable behaviors but also interpreted pupil responses,

drawing on teachers' deep familiarity with learners' communication patterns.

This multi-modal approach acknowledged that deaf learners' ways of knowing and expressing are valid forms of data, consistent with inclusive research practices (Santos et al., 2020).

Ethical Considerations

Throughout the initiative, strict ethical guidelines were observed to protect the rights and well-being of all participants. Informed consent was obtained from relevant educational authorities, the school, parents, and the pupils through their teachers. In case of any reporting, Pseudonyms were used in reporting to ensure confidentiality and protect participants' identities.

Confidentiality and anonymity of responses were maintained through data anonymization and secure storage. The research protocol received prior approval from Aga Khan University, IED, and ensured adherence to all ethical standards in line with (Santos et al., 2020) ethical guidelines.

Intervention Phases

The intervention unfolded through four structured phases aligned with the 3Rs framework:

Phase 1 - Sensitization and Awareness Creation: We conducted interactive sessions (with visual aids and sign-supported explanations) to introduce the pupils to the problem of plastic pollution and its environmental impacts.

Phase 2 - Collection of Plastic Waste: Pupils, supported by teachers, collected discarded plastic bottles within the school compound and the surrounding area. This promoted teamwork, responsibility, and environmental stewardship.

Phase 3 - Skill-Based Crafting Workshops: Using participatory demonstration methods, the pupils were trained to upcycle collected plastics into decorative vases, flowerpots, and wall hangings. Together with their teachers, we guided them in design and safety techniques, encouraging experimentation and creativity.

Phase 4 - Exhibition and Community Awareness Campaigns: The pupils showcased their products within the school and at Coco Beach, engaging community members in dialogue about recycling and inclusion. This final phase strengthened self-expression, confidence, and advocacy for sustainability.

Figure 2: *Summary Intervention and Observed Outcome*



Data Analysis

Data were analyzed thematically following Braun and Clarke (2019) six-step framework. Observation notes, interview transcripts, and visual artefacts were coded and categorized to identify emerging patterns related to creativity, confidence, social inclusion, and environmental stewardship. Recurrent themes were cross verified with teacher reflections to ensure reliability.

Findings and Discussion

Findings of the initiative reveal three Key themes: (i) Enhanced creativity and innovation, (ii) Increased confidence and inclusion, and (iii) Strengthened environmental literacy. These themes were derived through direct classroom observations, Interviews with the teachers, and Visual documentation and artifacts, such as drawings, gestures, and demonstrations that conveyed their experiences and emotions.

(i) Enhanced Creativity and Innovation

Pupils demonstrated significant improvement in creative engagement and problem-solving abilities across the intervention period. This was evident when, across 12 weekly observation sessions, the following indicators of creativity were noted:

Design experimentation: by the third week, about 78% of the pupils were able to modify the crafts designs independently compared to the first week where only 12% were able to do so in the first week. The pupils additionally were able to come up with different vase designs, illustrating innovativeness (See figure 3).

Peer sharing and mentorship: Most pupils were observed demonstrating techniques to their classmates and guiding those who had difficulty in assembling and cutting the materials by week 6, indicating both mastery and creative confidence.

Figure 3: Sample crafted plastic flower vases



Interviews with the teachers further corroborate these findings; this was evidenced when one of them explained: *“The pupils have begun bringing their own ideas; some even added bottle caps as flower petals to make the vase look like a sunflower”* (Teacher1, Interview 2024). Another teacher added: *“At first, they used to copy my examples but by the third session, they were showing me new ways to cut the bottles and arrange the colour; I could learn from some of them”* (Teacher 2, Interview 2024). All these illustrated progressions from simple cuts to complex patterns demonstrating creativity and innovativeness. Additionally, it showed that creativity is not a prerequisite for participation but emerges through enabling, hands-on learning environments. For deaf learners, who often face communication barriers that limit verbal expression, arts-based approaches provide alternative pathways for demonstrating understanding and exercising agency.

These findings align with (Bertling, 2023), who argue that art-based pedagogies enhance learner agency and engagement in sustainability education. The pupils’ creativity affirmed the transformative power of experiential ESD, where learning transcends words and is demonstrated through doing (UNESCO, 2020a). Importantly, the progression from imitation to innovation reflects Kolb (2014) experiential learning cycle, where concrete experience leads to reflective observation and active experimentation.

(ii) Increased Confidence and Inclusion

The Teachers' interviews and observation logs revealed a noticeable increase in pupils' confidence and participation. This was noted through behavioural indicators and visual documentation.

From Week 1 to Week 12, observed instances of learners guiding each other in crafting increased from 8 to 43 per session. Additionally, during the exhibition, over 80% of the pupils participated in the school exhibition and actively interacted with the community.

Visual documentation further triangulates these findings; analysis of exhibition photographs showed pupils using expressive sign language, smiling, and gesturing proudly at their work; many were observed demonstrating techniques to community members without the teacher's assistance.

This transformation resonates with Nussbaum (2000) capability Approach, which highlights empowerment through expanded opportunities and recognition. The public exhibition functioned as what Sen (1999) terms a "capability-enhancing" moment, where learners' skills were validated by the broader community. Furthermore, it aligns with (UNESCO, 2021) call for disability-inclusive ESD that values diverse abilities as sources of knowledge and creativity.

The exhibition format was particularly significant for deaf learners, as it provided a visual, non-verbal platform for demonstrating competence and challenging stereotypes. Community members' positive responses (observed through applause, purchase inquiries, and photo-taking) served as external validation that likely contributed to pupils' increased self-esteem.

(iii) Strengthened Environmental Literacy

The pupils' actions at the end of the initiative reflected increased environmental awareness across multiple indicators: this was observed through behavioral changes such as voluntary plastic bottle waste collection from the school compound by the 8th Week of the initiative, compared to before intervention. Additionally, several pupils also reportedly started collecting plastic bottles from home and bringing them to school to make flower vases. This voluntary collection behavior, extending beyond the structured project, suggests that environmental literacy had become internalized rather than merely performed for the research context. This aligns with Sterling and Orr (2020) characterization of transformative sustainability learning as fundamentally changing learners' relationships with their environment.

Interview with the teachers further confirmed these findings; the teachers' feedback showed that the pupils were always collecting the plastic bottles from the school compound and even outside, illustrating a protection for people and planet among the 5Ps of sustainable development. One teacher said, *"Today, we don't have to tell the pupils to keep their school compound clean; they do it even without our command"* (Teacher 1, Interview 2024).

Quantitative analysis indicators further triangulate these findings, revealing that approximately 850 plastic bottles were collected during the intervention.

These behavioral changes illustrate Kolb (2014) experiential learning model, where learners construct understanding through concrete experience and reflection-in-action. The social action project thus moved environmental learning from abstract concepts to tangible, embodied practice. This resonates with Heumann (2023) that found that localized, hands-on interventions foster long-lasting environmental consciousness among young learners.

Limitations

Despite the positive outcomes, several challenges hindered the initiative's scalability. Observation records indicated that the 40-minute creative arts period was insufficient for completing the crafts. Teachers also reported difficulties in translating complex sustainability terms into sign language, which

not only required additional explanation time but also highlighted broader language barrier issues. The limited vocabulary available in sign language for environmental concepts made it challenging to convey nuanced ideas, occasionally leading to misunderstandings or oversimplifications. Moreover, community attitudes presented a barrier; many parents were reluctant to allow learners to participate in public exhibitions, citing concerns about safety and stigma. Market resistance was another issue; people admire the vases but still prefer glass or ceramic ones. Overcoming these challenges requires systemic reforms and enhanced collaboration between educators, parents, and community leaders to ensure inclusive and effective sustainability education.

Conclusion

This study addressed the persistent problem of the exclusion of deaf female learners from climate education and environmental action programs, despite their vulnerability to the effects of climate change. By implementing a participatory, arts-based recycling initiative, the study demonstrated that inclusive, hands-on learning can transform environmental education into a meaningful and empowering experience for marginalized learners.

Key findings revealed that the project significantly enhanced learners' creativity, confidence, and environmental literacy while fostering social inclusion and challenging gender and disability stereotypes. Also, the initiative illustrated the potential of ESD to advance multiple Sustainable Development Goals, particularly SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities) and SDG 13 (Climate Action).

These findings suggest that integrating creative, participatory pedagogies into national curricula can make sustainability education more accessible and relevant for learners who are often overlooked. The study also suggests that inclusive ESD interventions can support learner agency and community engagement, contributing to environmental and social change at the local level. However, the study faced limitations related to time constraints within the school timetable, limited availability of sign language barrier, and resistance from some community members toward upcycled products. These challenges highlight the need for systemic support and policy reforms to institutionalize inclusive, arts-based environmental education.

Future research should examine the long-term behavioural impacts of such initiatives, explore similar interventions across different disability groups, and assess their scalability within formal and non-formal education systems in East Africa.

In summary, this study reaffirms that when education embraces inclusivity, creativity, and action, it becomes a powerful tool for social and ecological transformation, empowering even the most marginalized learners to become active stewards of a sustainable future.

Recommendations

Based on these findings, the following recommendations are offered:

For curriculum developers: Integrate arts-based and experiential sustainability projects into creative arts and environmental studies curricula. This integration should include structured time for hands-on activities rather than treating them as supplementary or extracurricular.

For school administrators: Establish partnerships among schools, NGOs, and local enterprises to support recycling initiatives, develop markets for upcycled products, and address community resistance through awareness campaigns.

For policymakers: Prioritize funding and policy frameworks that embed inclusive ESD in special needs schools. This includes allocating dedicated time in timetables and resources for experiential sustainability

education.

For community stakeholders: Conduct sensitization campaigns to challenge disability stigma and foster appreciation for sustainable, locally made goods. Community exhibitions, as demonstrated in this study, can serve as effective platforms for shifting attitudes.

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