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Environmental Education for Sustainable Development and Environmental Participation: Insights from Students in Antananarivo

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Abstract— *In Madagascar, numerous non-governmental organizations active in the environmental sector integrate Environmental Education for Sustainable Development (EESD) through various awareness-raising activities conducted in schools. Within the framework of the formal education system, teachers and students play a key role in this educational dynamic. This approach aligns with the broader objectives of the National Policy on Environment for Sustainable Development and contributes to achieving the Sustainable Development Goals, particularly those related to the sustainable management of natural resources and the improvement of living conditions. However, the effectiveness of these initiatives in fostering behavioral change among students remains to be further examined. The present study analyzes the impact of communication and best practices in EESD on the environmental behaviors of high school students from Ivato and LMA in Antananarivo. It is based on the hypothesis that participatory and context-based communication fosters the appropriation of knowledge and the sustainable transformation of behaviors. A questionnaire survey was conducted among 146 students in the final two grades of secondary education in these two institutions. The results indicate that 64% of students exposed to regular EESD activities (such as environmental clubs, educational outings, or tree planting) demonstrate increased ecological awareness and more responsible practices. The discussion highlights the need to integrate EESD more sustainably into school curricula in order to strengthen its effectiveness and consolidate civic attitudes in favor of environmental protection.*

Keywords—*Environmental education, behavioral change, sustainable development, awareness raising, Madagascar.*

I. Introduction

"*Transforming lives while preserving the planet*" is the guiding ambition of the 17 Sustainable Development Goals (SDGs), a universal framework for action adopted by the member states of the United Nations in September 2015. These goals aim to reconcile economic progress, social equity, and environmental protection, calling for profound transformations in behaviors and lifestyles. In this context, education occupies a central place: it serves as a strategic lever for fostering ecological awareness and promoting sustainable practices from an early age.

At the international level, EESD has gradually emerged as a cornerstone of the socio-ecological transition. Its purpose is not only to transmit knowledge but also to foster the development of citizens capable of adopting responsible behaviors and taking concrete action to preserve the environment[1]. In many countries, innovative pedagogical approaches have been developed to integrate sustainability into curricula from early childhood to higher education. Recent research shows that EESD effectively strengthens pro-environmental attitudes and enhances youth participation in community-based projects (Blanco et al., 2020).

In Madagascar, EESD plays a central role in promoting responsible ecological behaviors among younger generations. Various NGOs and associations—such as IMPACT Madagascar, SEED Madagascar, and ADES Madagascar—integrate this approach through awareness-raising, educational, and action-oriented activities in schools. These efforts contribute to achieving the Sustainable Development Goals related to the sustainable management of natural resources and the improvement of living conditions (Blanco et al., 2020; Schüßler et al., 2019). However, despite the multiplication of such initiatives, questions remain about their actual effectiveness in influencing students' attitudes and behaviors. The challenge is no longer limited to the transmission of knowledge but lies in fostering concrete and sustainable practices within school communities.

To address this issue, the present study focuses on two secondary schools in Antananarivo: the Lycée d'Ivato and the Lycée Moderne Ampefiloha, which are representative of the educational and environmental challenges faced in urban settings. These schools provide relevant observation sites for analyzing how scientific communication and the dissemination of good environmental practices contribute to building a shared ecological consciousness.

This research examines the impact of EESD initiatives on environmental participation and sustainable behaviors among high school students in Antananarivo. It is based on the hypothesis that participatory and context-based communication

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fosters the appropriation of knowledge and the sustainable transformation of behaviors.

II. Literature Review

2.1 Environmental Education and Its Contribution to the Sustainable Development Goals

Environmental education (EE) constitutes a key lever for achieving the Sustainable Development Goals (SDGs) by fostering awareness, critical thinking, and concrete engagement in sustainable practices. As a strategic driver, EE contributes notably to SDG 4 (*Quality Education*), SDG 12 (*Responsible Consumption and Production*), and SDG 13 (*Climate Action*). Initiatives such as the AWARE project by the SeaTrust Institute exemplify this dynamic by engaging students in practical actions to address local environmental challenges while simultaneously enhancing their global awareness and community participation (Alonso, 2022).

Figure 1: Environmental Education for Sustainable Development and its contribution to SGDs 4, 12 and 13

Integrating environmental themes into curricula allows for the connection of theory and practice while developing eco-citizenship skills (Hasan, 2025). In Madagascar, several educational initiatives aim to operationalize these principles through EESD. Teacher trainers play a crucial role in disseminating interdisciplinary approaches and promoting sustainable behaviors, although their efforts are sometimes constrained by rigid curricula and limited institutional support (Hasan, 2025; Esteban Ibáñez et al., 2020). Among these programs, those implemented in certain high schools in Antananarivo stand out for incorporating participatory activities—such as environmental clubs, tree-planting campaigns, and awareness workshops—that foster learning through action and the development of responsible attitudes among students. These initiatives contribute to strengthening environmental participation while consolidating practical knowledge related to sustainability.

Furthermore, environmental education supports the conservation of natural resources and the transition toward sustainable lifestyles, provided it is coherently integrated into national educational policies (Silva & Araújo, 2024; Permanasari et al., 2021). To maximize its impact, it remains essential to reinforce resources and institutional support mechanisms to ensure effective and sustainable implementation.

2.2 Foundations and Implementation of EESD

EESD provides a strategic framework aimed at strengthening the understanding of the links between human behaviors and environmental sustainability, emphasizing the need for educational strategies that empower individuals to take responsibility for protecting their environment. Various pedagogical approaches are integrated within this framework to develop the knowledge, skills, and attitudes necessary to address contemporary environmental challenges (Llopiz-Guerra et al., 2024; Permanasari et al., 2021; Sarma, 2017).

EESD helps raise students' awareness of environmental issues and encourages their active participation in sustainability efforts, both locally and globally (Llopiz-Guerra et al., 2024). Such issues include deforestation, inefficient waste management, water pollution, and biodiversity loss—challenges that directly affect community quality of life. EESD also serves as a critical preventive tool against environmental degradation, particularly in areas highly exposed to urban pollution and increasing anthropogenic pressures. To be truly effective, this education must be based on an interdisciplinary curriculum, contextualized to local cultural realities, and founded on the principles of lifelong learning (Permanasari et al., 2021).

Innovative pedagogical approaches, such as project-based learning and community engagement, have proven particularly effective in strengthening environmental knowledge and promoting the adoption of sustainable ecological behaviors among learners (Sarma, 2017). However, for these educational initiatives to generate lasting impact, it is essential to develop a comprehensive framework linking EESD to the broader objectives of sustainable development. Such alignment ensures coherence between educational actions and public policies. Several authors also emphasize that education alone cannot guarantee sustainability if it is not accompanied by deep structural reforms in governance, economic practices, and industrial sectors. Thus, the transition toward a sustainable future requires an integrated and collaborative approach, combining education, public policy, and community engagement (Permanasari et al., 2021).

2.3 Environmental Education and the Socio-Ecological Transformation of Youth in Madagascar

Environmental education promotes sustainable practices, biodiversity conservation, and local economic development in Madagascar. Initiatives such as those led by the Mitsinjo Association, including the training of para-ecologists, strengthen both ecosystems and livelihoods (Dolch et al., 2015). In high schools in Antananarivo, EESD enhances students' ecological awareness and their participation in concrete actions, contributing to a shared environmental culture.

At the same time, environmental education supports the diversification of income sources and reinforces the economic resilience of rural households (Neudert et al., 2015). Experiences such as the production of Opuntia seed oil illustrate the potential of income-generating activities that reconcile economic development with environmental sustainability (Hänke, 2016). However, persistent poverty and natural resource degradation limit the reach of these initiatives, necessitating an approach that considers structural constraints to maximize long-term effects.

Recent research emphasizes that experiential learning, community engagement, and participatory communication are major drivers of sustainable behavioral change. For instance,

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Blanco et al. (2020) show that EESD programs in Madagascar, particularly those implemented by the Duke Lemur Center, stimulate active student involvement in concrete environmental protection actions, reinforcing their sense of ecological responsibility. Similarly, Loor Zárate et al. (2024) demonstrate that participatory approaches foster deeper and more durable engagement than purely theoretical programs.

Nevertheless, several limitations remain. Schüßler et al. (2019) note that economic precarity, lack of educational resources, and insufficient institutionalization of EESD hinder its implementation in low-resource contexts. In Madagascar, Reibelt et al. (2014) observe that teachers tend to emphasize moral and social dimensions over ecological issues, creating a gap between NGO objectives and local educational practices. Finally, Brias-Guinart et al. (2020) highlight that most evaluations focus on measuring cognitive gains or attitude changes, without thoroughly assessing long-term behavioral transformations.

2.4 Strategic and Institutional Frameworks of Environmental Education in Madagascar

The integration of EE into Madagascar's public policies aligns with the international momentum driven by SDGs and UNESCO's guidelines on Education for Sustainable Development (ESD). Since the 2000s, several national frameworks have sought to institutionalize this approach, notably through the National Environmental Education Policy and programs led by the Ministry of Environment and Sustainable Development (MEDD). These initiatives aim to strengthen citizens' environmental awareness and promote responsible behaviors within local communities (MEDD, 2019). In this context, the MEDD organized a conference in 2025 to facilitate the exchange of best practices, reinforce collaboration among local and national stakeholders, and support the effective implementation of environmental policies.

Despite these advances, implementation remains uneven and heavily dependent on partnerships between public institutions, NGOs, and educational actors (Schüßler et al., 2019). Collaborations between the MEDD, the Ministry of National Education (MEN), and organizations such as the Durrell Wildlife Conservation Trust and WWF Madagascar have enabled the development of contextualized educational modules and the training of teacher facilitators. These initiatives adopt a participatory and adaptive approach, aiming to bridge scientific knowledge with local practices.

However, the reach of these programs is still constrained by institutional and financial limitations. The lack of intersectoral coordination, the weak integration of EE into official curricula, and the insufficiency of teaching resources hinder the widespread adoption of sustainable educational practices (Schüßler et al., 2019; Reibelt et al., 2014). Moreover, Malagasy environmental policies often remain reactive to ecological emergencies rather than proactive in fostering an environmental culture embedded within the education system (Permanasari et al., 2021).

In this context, strengthening educational governance emerges as a key priority. Consolidating networks of local actors, decentralizing educational initiatives, and developing long-term evaluation mechanisms could enhance the appropriation of EE by rural communities. Additionally, the systematic integration of EESD into teacher training policies and national curricula would firmly embed environmental sustainability at the core of territorial development.

2.5 School Engagement and the Development of Environmental Competencies in Support of Sustainable Development

The relationship between school engagement, environmental competencies, and sustainable development within the framework of EESD is multidimensional. Schools play a pivotal role in fostering ecological citizenship, which is essential for promoting sustainable practices and strengthening students' environmental culture. Such engagement can be reinforced through innovative pedagogical strategies and increased involvement of local communities.

Education contributes to the empowerment of learners by integrating sustainability principles into curricula, thereby enhancing critical thinking and active participation in ecological initiatives (Ben Mabrouk et al., 2025). Research has shown that meeting students' fundamental psychological needs—competence, autonomy, and relatedness—positively influences their motivation, engagement, and environmental literacy (Frensley et al., 2022).

The coherent integration of environmental topics into school programs, extracurricular activities, and community projects significantly enhances awareness and the skills necessary for sustainability (Almoudhan et al., 2024). This approach also fosters the development of green skills, which are increasingly valued in the labor market and closely linked to heightened ecological consciousness (Rahmaningtyas et al., 2023).

Educational institutions are therefore encouraged to adopt a holistic approach, embedding environmental education throughout school life to cultivate a generation of responsible and committed actors in favor of sustainability (Almoudhan et al., 2024). Moreover, the involvement of local communities in educational initiatives serves as a major lever for strengthening students' environmental skills and awareness, while contributing to the achievement of the Sustainable Development Goals (Lange, 2015). However, despite its importance, the integration of environmental education faces challenges related to unequal access to educational resources and participation opportunities, which can sometimes limit the overall effectiveness of these programs.

2.6 Importance of Communication for Promoting Ecological Behavioral Change

Communication plays a fundamental role in promoting pro-environmental behaviors and in the preservation of natural resources. It serves as a critical link between knowledge and action, enhancing public awareness and participation in sustainability initiatives. By employing diverse communication strategies, stakeholders can mobilize communities around collective environmental efforts.

The roles of communication in environmental awareness include:

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- *Public awareness*: Communication contributes to a better understanding of environmental issues by highlighting the impact of human activities on ecosystems.
- *Community engagement*: Effective messaging encourages participation in environmental projects, such as recycling programs and conservation initiatives (Salampessy et al., 2021).
- *Partnerships*: Strategic communication facilitates collaboration across sectors (government, NGOs, private sector), leading to more effective environmental management.

The impacts of nonverbal communication include:

- *Visual symbols*: Nonverbal cues, such as recycling logos or ecological gestures, significantly influence public attitudes and behaviors toward environmental protection (Kidari et al., 2025).
- *Emotional engagement*: Artistic expressions and visual campaigns elicit emotional responses, strengthening individual involvement in environmental causes (Kidari et al., 2025).

Although communication is essential for fostering ecological behaviors, not all efforts yield the same results. Poorly designed or unclear communication can lead to public indifference or misunderstandings about environmental issues, underscoring the importance of carefully crafted messages and strategies.

III. Materials and Methods

This study adopted a quantitative approach to analyze the impact of Environmental Education for Sustainable Development (EESD) on the environmental behaviors of high school students in Antananarivo. The research was conducted in two representative public institutions: Ivato High School and Lycée Moderne Ampefiloha (LMA).

3.1. Sampling and Target Population

The survey involved a sample of 146 students, drawn from the first and final grades of both schools. This selection was based on the cognitive maturity and higher autonomy of these students, which foster more critical thinking on environmental issues and greater involvement in both curricular and extracurricular activities related to environmental protection.

3.2. Data Collection Tools and Procedures

The main data collection instrument was a structured questionnaire administered at the beginning of 2025. It included three sections:

- *Awareness and participation in EESD*: identification of environmental education activities attended and assessment of their perceived usefulness.
- *Ecological behaviors*: inventory of everyday environmental practices (water and energy saving, waste management, participation in collective actions) and evaluation of the influence of educational activities on behavioral change.
- *Perceptions and suggestions:* students' views on the importance of EESD and their recommendations for improvement.

The questionnaire was administered in person during classroom sessions under the supervision of teachers, ensuring a high response rate and data reliability. Anonymity was guaranteed to encourage honest and spontaneous responses.

3.3. Data Analysis

Data were processed and analyzed using Excel and SPSS 25. Descriptive statistics (frequencies, percentages, and means) were used to outline general trends in students' environmental attitudes and practices. Correlation analyses were then performed to examine relationships between participation in EESD activities and the adoption of ecological behaviors. The results were interpreted in light of theoretical frameworks related to participatory communication and experiential learning and compared with existing literature to assess the effectiveness and limitations of environmental education programs in Malagasy secondary schools.

IV. Findings

4.1 Awareness and Engagement of Malagasy High School Students in EESD

The results reveal the level of knowledge and participation of the 146 surveyed students, highlighting their degree of involvement in eco-citizen actions carried out within their schools.

The majority of students (85%, 124 of 146) reported having heard about EESD, but only 62% (91 students) actively participate in environment-related activities. In addition, 38% (55 students) indicated that environmental activities are held regularly in school, while 48% (69 students) reported that such activities occur only occasionally.

4.2 Educational Practices and Environmental Initiatives in High Schools

The data reveal a variety of environmental education activities implemented in the surveyed high schools, highlighting their contribution to students' ecological awareness. Among the 146 students surveyed, 68% (99 students) reported participating in reforestation activities, 59% (86 students) in public space cleaning initiatives, 42% (61 students) in waste sorting and collection, and 26% (38 students) in environmental competitions or exhibitions. These results suggest that hands-on and participatory activities play a central role in environmental education within these schools.

Reforestation remains the most common activity, followed by the cleaning of public spaces and waste sorting.

4.3 Adoption of Ecological Practices by High School Students

The results highlight the ecological behaviors adopted by the 146 surveyed students, demonstrating the influence of environmental education activities on their daily practices. Specifically, 71% of students (104 of 146) reported practicing water conservation at school, 67% (98 students) engaged in energy-saving behaviors such as reducing electricity use, 49% (72 students) regularly participated in waste sorting, and 54% (79 students) made efforts to reduce plastic consumption.

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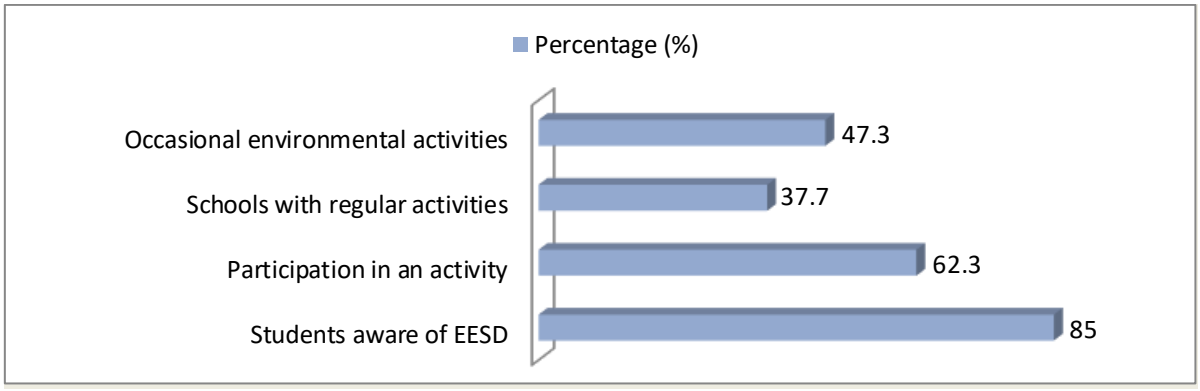

Figure 2: Awareness and Participation of Students in EESD

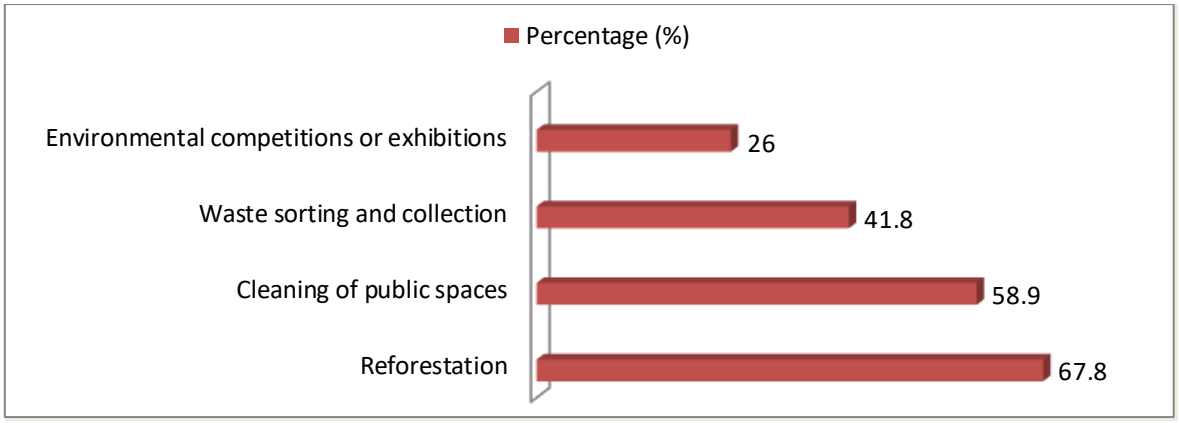

Figure 3: Types of Environmental Education Activities Conducted in High Schools

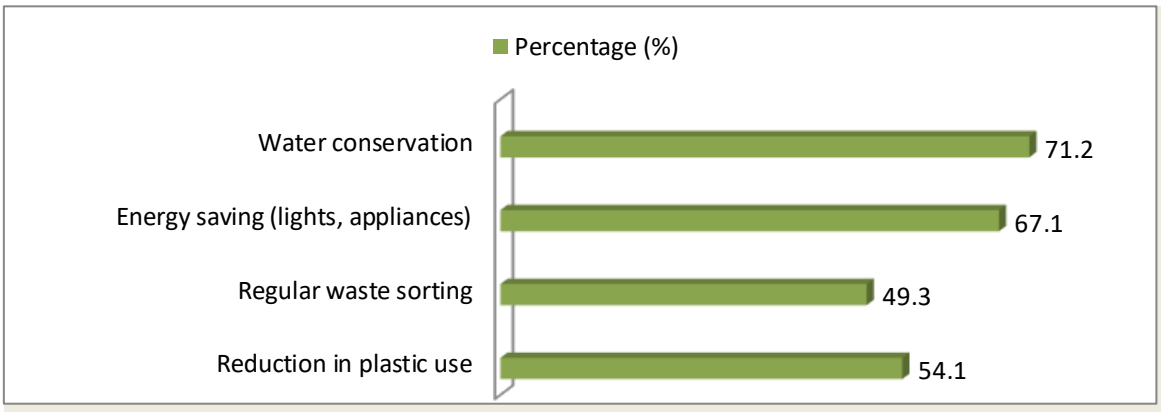

Figure 4: Ecological Practices Adopted by High School Students

Water- and energy-related behaviors are the most widely adopted by students, particularly in connection with the services provided by JIRAMA, which faces frequent outages and irregular water and electricity supply.

4.4 Influence of EESD on Sustainable Behaviors

The effects of environmental education actions are evident in the adoption of sustainable behaviors among the surveyed high school students.

EESD demonstrates a significant contribution (64%), with 94 of 146 students reporting that it fosters a sense of ecological responsibility, notably reflected in their domestic environmental behaviors. Additionally, 52% of students (76 of 146) indicated observable behavioral changes at home as a result of EESD, while 45% (66 of 146) reported that it contributed to raising awareness among family members and friends.

4.5 Challenges Encountered in the Implementation of EESD

The following graph highlights the challenges reported by students in integrating EESD into their school activities.

The most frequently cited obstacle is a lack of material resources, reported by 48% of students (70 of 146). This is followed by limited time within the school curriculum, indicated by 31% of students (45 of 146), and low teacher involvement, reported by 21% of students (31 of 146). These findings highlight the critical need for adequate resources,

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curriculum time, and teacher engagement to ensure the effective implementation of EESD.

4.6 Suggestions for Improving EESD

These measures aim to improve both the efficacy and impact of environmental education initiatives targeting high school students.

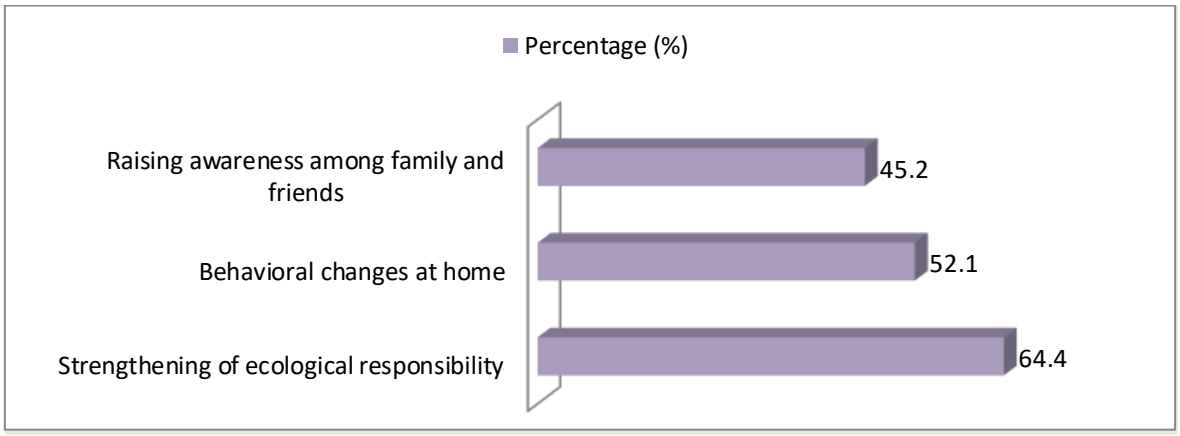

Figure 5: Impact of EESD on Sustainable Behaviors

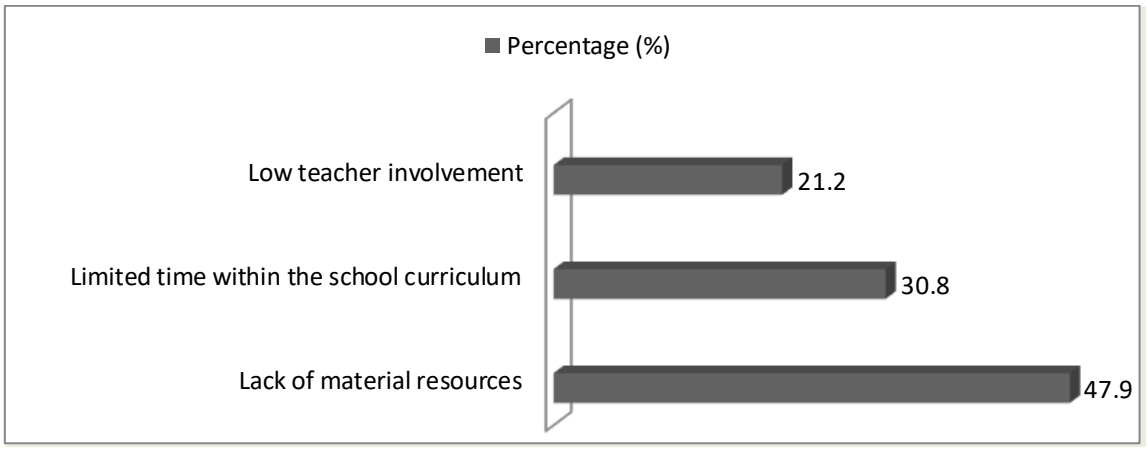

Figure 6: Challenges Encountered

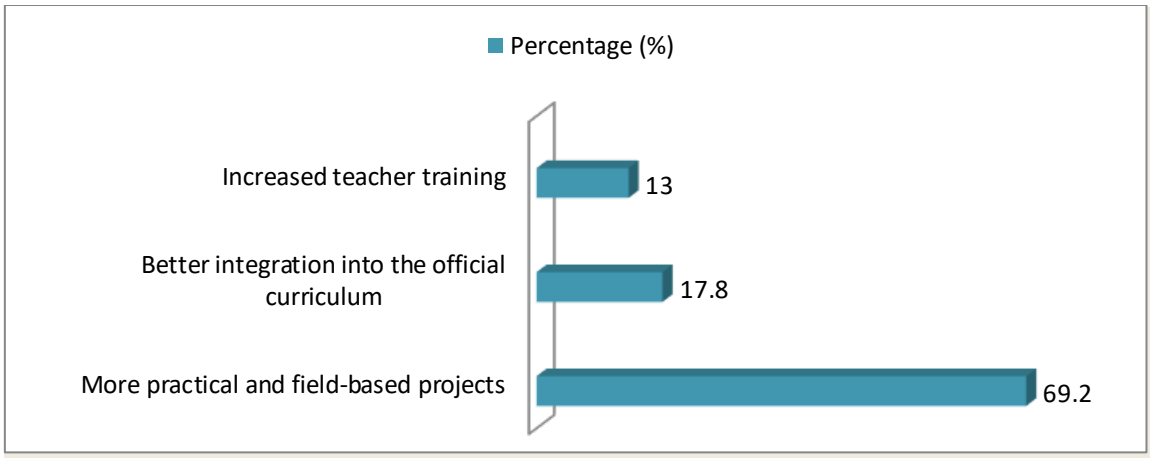

Figure 7: Suggestions to Strengthen Environmental Education

Students primarily recommend increasing practical and participatory activities, with 101 of 146 students (69%) indicating that this would enhance the effectiveness of EESD. Additionally, 18% (26 students) suggested that integrating EESD into the official curriculum would be beneficial, while 13% (19 students) recommended providing additional teacher training.

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V. Discussion

5.1 High Level of Awareness and Strong Student Engagement in EESD

The results indicate a relatively high level of student awareness of EESD, with the majority having heard about environmental initiatives implemented in their schools. This awareness reflects the gradual dissemination of sustainable development principles throughout the Malagasy educational system. However, actual participation varies across schools and is often dependent on the presence of motivated teachers or the occasional support of local NGOs. These findings align with the analyses of Reibelt et al. (2014), who note that EESD in Madagascar remains heavily reliant on external actors and local dynamism rather than on a centralized institutional policy. Similarly, Blanco et al. (2020) emphasize that awareness alone is insufficient to generate sustainable behaviors: it must be accompanied by regular and contextually relevant practice. Indeed, in Madagascar, the adoption of ecological behaviors by students remains contingent upon the availability of infrastructure, institutional support, and the concrete integration of practices into their daily school and family life.

5.2 Low Frequency of Environmental Education Activities

The recorded activities — reforestation, waste management, maintenance of green spaces, and collective clean-ups — reflect an essentially practical and community-based approach to environmental education. This type of experiential learning promotes youth responsibility and a concrete understanding of ecological issues, in line with the observations of Loor Zárate et al. (2024) and Permanasari et al. (2021). Nevertheless, the frequency of these activities remains low in some Malagasy high schools, where environmental education is still perceived as a peripheral activity rather than a core educational focus. As noted by Schüßler et al. (2019), the lack of systematic integration of EESD into the curriculum limits the transformative potential of these initiatives. Therefore, stronger institutionalization and regular planning of activities appear to be essential conditions for the sustainability of learning outcomes. Indeed, in Madagascar, some schools have active environmental clubs and regular cleaning or reforestation projects, while others only have access to occasional interventions, which constrains the overall impact on student behaviors.

5.3 Adoption of Ecological Practices by High School Students

The most frequently reported ecological behaviors among high school students — energy saving (lights, electrical appliances), waste sorting, tree planting, reduction of water and plastic consumption, and artisanal recycling — reflect a growing internalization of environmental values by the youth. These findings corroborate the observations of Mabrouk et al. (2025) and Frensley et al. (2022), who emphasize the role of education as a driver of ecological empowerment among Madagascar's younger generations.

However, these practices remain largely confined to the school environment and do not always translate into sustainable changes at the family or community level. As noted by Lange (2015), the durability of behaviors depends on the ability to connect formal learning with collective action in everyday life. This requires strengthening intergenerational environmental communication to promote the dissemination of best practices beyond the school setting.

Indeed, in Madagascar, the integration of sustainable behaviors is still more theoretical than practical. Educational programs raise students' awareness of environmental issues, but this knowledge rarely translates into regular and collective actions in daily life. To enhance the effectiveness of EESD, it would be pertinent to link school curricula with concrete initiatives, such as participation in reforestation projects, the installation and use of waste bins within school grounds, or the creation of educational gardens. These measures allow students to put acquired knowledge into practice and develop lasting sustainable habits.

5.4 Participatory Approach, Sustainable Behaviors, and Ecological Awareness

Regular participation in environmental activities appears to be correlated with a better understanding of sustainability issues and a greater propensity to adopt eco-responsible behaviors. This link between active participation and attitude transformation is supported by Sarma (2017), who demonstrates that environmental education fosters deeper engagement when it combines theoretical knowledge with concrete actions. Similarly, Sharma et al. (2024) emphasize the importance of integrated learning that connects critical reflection with community practice.

The findings of the study confirm that EESD, when implemented through a participatory approach, promotes not only knowledge acquisition but also motivation to act. Nevertheless, as Brias-Guinart et al. (2020) note, measuring behavioral impact remains complex, as attitude changes do not always immediately translate into lasting transformations. In high schools, although students report adopting certain ecological practices, such as waste sorting or energy conservation (with water use being limited at school and some classrooms lacking light fixtures), these actions often remain confined to the school environment and do not consistently extend into their family or community life.

5.5 Structural Constraints Limiting the Effectiveness of EESD

The reported challenges — lack of teaching materials, insufficient budgets, limited institutional support, and absence of continuous training — constitute major obstacles to the sustainability of EESD. In Madagascar, this results in schools lacking waste bins for sorting, educational gardens, or reforestation projects, as well as irregular water and electricity infrastructure, limiting the practical implementation of ecological behaviors. These constraints confirm the observations of Schüßler et al. (2019) and Reibelt et al. (2014), who note that the success of environmental programs depends on logistical resources and the motivation of educational actors. Additionally, the economic precariousness of families reduces the priority given to environmental issues (Neudert et al., 2015), highlighting the need for strengthened political and financial support to enhance the effectiveness of EESD.

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5.6 Strategies to Enhance the Educational and Behavioral Impact of EESD

Students' suggestions — strengthening practical activities, creating ecological clubs such as the already operational Club Vintsy, providing additional teacher training, and involving the local community — reveal a clear understanding of the key levers needed to improve EESD. These proposals align with the recommendations of Dolch et al. (2015) and Hänke (2016), who advocate for an inclusive approach combining participatory learning and the valorization of local knowledge. Furthermore, integrating participatory communication into educational actions, as supported by Servaes (2008) and Thomas & Mefalopulos (2009), could enhance the coherence between learning, engagement, and collective action. Malagasy students, by actively participating in these initiatives, demonstrate real potential to translate acquired knowledge into sustainable practices. Thus, a contextualized EESD program, coordinated among schools, teachers, and local communities, appears as a crucial lever for consolidating ecological behaviors among youth and supporting long-term sustainable development goals.

VI. Conclusion

This study analyzed the impact of environmental education initiatives on the participation and sustainable behaviors of high school students in Antananarivo, based on the hypothesis that participatory and context-specific communication fosters knowledge appropriation and behavioral transformation. The results indicate that students are gradually adopting ecological practices. Their recommendations — strengthening practical activities, developing ecological clubs such as Club Vintsy, providing teacher training, and engaging the local community — highlight the need for a concrete and collaborative approach to sustain these behaviors. However, these practices remain largely confined to the school environment. As a direction for future research, one key question is: *How can students' environmentally responsible behaviors be effectively transferred and sustained in family and community contexts?*

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