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Eco-Edu Puntondo: Integrating Contextual Mathematics and Agritourism for Sustainable Environmental Education

Eco-Edu Puntondo: Integrasi Matematika Kontekstual dan Agrowisata untuk Pendidikan Lingkungan Berkelanjutan

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Abstract

The Eco-Edu Puntondo Community Partnership Program (PKM) aimed to integrate contextual mathematics, environmental education, and agritourism potential to support participatory and sustainable learning at the Puntondo Environmental Education Centre (PPLH Puntondo), Takalar Regency. The program was conducted during the even semester of the 2025/2026 academic year. Participants included PPLH Puntondo staff, the principal and teachers of Asy-Syamsi Kindergarten, and Mathematics Education students from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar (FMIPA UNM). The program involved identifying the partner's needs, mapping environmental and agritourism potential, conducting participatory discussions, facilitating the design of contextual mathematics learning activities, and developing the Eco-Edu Puntondo digital platform. Mathematical concepts were integrated into observation, experimentation, data processing, problem-solving, and exploration of the surrounding environment. The results included the development of learning activities that utilised the environment and agritourism as learning resources, improved participants' understanding of contextual mathematics learning and environmental issues, and the establishment of a digital platform for program information, education, and documentation. The program strengthened the capacity of partners and university students to design learning experiences relevant to everyday life while fostering numeracy literacy and environmental awareness. Eco-Edu Puntondo has the potential to be further developed as an adaptive, locally grounded environmental education model that can be replicated in other regions.

Abstrak

Pengabdian Kemitraan Masyarakat (PKM) Eco-Edu Puntondo bertujuan mengintegrasikan matematika kontekstual, pendidikan lingkungan, dan potensi agrowisata dalam mendukung pembelajaran yang partisipatif dan berkelanjutan di Pusat Pendidikan Lingkungan Hidup (PPLH) Puntondo, Kabupaten Takalar. PKM ini dilaksanakan pada semester genap Tahun Akademik 2025/2026. Peserta kegiatan meliputi staf PPLH Puntondo, kepala sekolah dan guru TK Asy-Syamsi, serta mahasiswa Pendidikan Matematika FMIPA UNM. Pelaksanaan program mencakup identifikasi kebutuhan mitra, pemetaan potensi lingkungan dan agrowisata, diskusi partisipatif, pendampingan perancangan aktivitas pembelajaran matematika kontekstual, serta pengembangan platform digital Eco-Edu Puntondo. Konsep matematika diintegrasikan dengan aktivitas pengamatan, eksperimen, pengolahan data, pemecahan masalah, dan eksplorasi lingkungan sekitar. Hasil kegiatan menunjukkan tersusunnya rancangan aktivitas pembelajaran yang memanfaatkan lingkungan dan agrowisata sebagai sumber belajar, meningkatnya pemahaman peserta mengenai pembelajaran matematika kontekstual dan isu lingkungan, serta tersedianya platform digital sebagai media informasi, edukasi, dan dokumentasi program. Kegiatan ini memperkuat kapasitas mitra dan mahasiswa dalam merancang pembelajaran yang relevan dengan kehidupan sehari-hari sekaligus menumbuhkan literasi numerasi dan kepedulian lingkungan. Eco-Edu Puntondo berpotensi dikembangkan sebagai model pendidikan lingkungan berbasis potensi lokal yang adaptif dan dapat direplikasi di wilayah lain.

Keywords: Eco-Edu Puntondo; contextual mathematics; environmental education; sustainable agritourism; community partnership.

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1. Introduction

Environmental degradation, climate change, biodiversity loss, and the unsustainable use of natural resources have increased the urgency of preparing communities capable of making environmentally responsible decisions (Baga et al., 2024; Kementerian PPN/Bappenas, 2024). Education plays a central role in this effort because it can develop not only environmental knowledge but also the values, attitudes, and competencies required to contribute to sustainable development. The *Education for Sustainable Development: A Roadmap* emphasizes the importance of transforming learning environments, strengthening educators' capacities, empowering young people, and promoting local-level action to achieve the Sustainable Development Goals (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020). Environmental education should therefore be implemented through participatory and context-sensitive learning that connects sustainability issues with learners' daily experiences (Djam'an, 2025).

Mathematics has considerable potential to support environmental education because it provides tools for observing patterns, measuring environmental conditions, analyzing data, modelling change, comparing alternatives, and evaluating the consequences of decisions (Djam'an dkk, 2023a). However, mathematics is still frequently taught as a collection of abstract procedures that are disconnected from real-life situations. Li and Tsai (2021) argued that sustainability and mathematics education remain insufficiently connected in classroom practice, despite increasing international attention to Education for Sustainable Development. Similarly, a systematic review by Vásquez et al. (2023) found that mathematics and statistics education can effectively support sustainability-oriented learning, although teachers often have limited knowledge and experience in designing such instruction.

The need for relevant and contextual mathematics learning is particularly important in Indonesia (Djam'an dkk, 2023b). The PISA 2022 results showed that only 18% of Indonesian students achieved at least Level 2 proficiency in mathematics, compared with the OECD average of 69% (Organisation for Economic Co-operation and Development [OECD], 2023). At this proficiency level, students are expected to interpret familiar situations and represent them mathematically. These results indicate the continuing need for learning experiences that enable students to apply mathematics to authentic situations rather than merely reproduce formulas and algorithms. Contextual mathematics learning can address this need by positioning real environmental and social problems as meaningful starting points for observation, experimentation, data processing, reasoning, and problem-solving.

One relevant approach is place-based education, which uses the local environment, community, culture, and everyday activities as learning resources (Djam'an dkk, 2026a). Through direct engagement with a particular place, learners can establish meaningful relationships between academic concepts and the realities of their communities. A systematic review by Yemini et al. (2025) demonstrated that place-based education can create authentic learning experiences, strengthen learners' relationships with their local environments, and promote community and civic engagement. Accordingly, environmental settings can function as living laboratories in which mathematical concepts are explored through activities such as measuring land and buildings, calculating water or energy consumption, analyzing waste generation, interpreting environmental data, and examining patterns in natural and agricultural systems.

Agritourism offers a valuable context for integrating environmental education with contextual mathematics. It encompasses educational activities, hospitality, outdoor recreation, entertainment, and direct engagement with agricultural environments (Bukhori & Nurmalina, 2021; Chase et al., 2018). When employed pedagogically, agritourism can provide opportunities for learners to investigate agricultural production, biodiversity, renewable energy, resource management, and interactions between communities and ecosystems. Mathematical concepts can be embedded in these activities through estimating crop yields, measuring growing areas, calculating production costs, interpreting visitor data, examining energy efficiency, and assessing the environmental impacts of tourism-related activities. Thus, agritourism can serve not only as an economic activity but also as an experiential learning environment that supports environmental awareness and sustainable practices.

The Puntondo Environmental Education Centre (*Pusat Pendidikan Lingkungan Hidup* [PPLH] Puntondo) in Takalar Regency possesses considerable potential for implementing this integrated approach. Its natural environment, environmental education facilities, renewable-energy infrastructure, agricultural activities, accommodation facilities, and community-based programmes provide diverse resources for contextual and participatory learning. Preliminary discussions and observations, however, indicated that these resources had not yet been systematically organized into contextual mathematics activities or integrated into a digital learning platform. Environmental education activities were available, but structured materials connecting mathematics, environmental issues, and agritourism potential remained

limited. Strengthening the capacity of the centre's staff and educators to design such activities was therefore necessary to ensure that local resources could be used more effectively and sustainably.

Community participation is essential in responding to this need because educational programmes are more likely to be relevant and sustainable when they are developed collaboratively with local partners. Rather than treating the community solely as a programme recipient, a participatory approach recognizes partners as contributors who possess contextual knowledge, practical experience, and an understanding of local environmental challenges. Collaboration among university lecturers, students, PPLH Puntondo staff, and teachers can facilitate the co-design of learning activities that are pedagogically meaningful, environmentally relevant, and feasible within the local setting. The involvement of Mathematics Education students also provides authentic professional learning through which they can apply pedagogical knowledge, contextualize mathematical concepts, and develop experience in community-based environmental education.

Based on these considerations, the Eco-Edu Puntondo Community Partnership Program was designed to integrate contextual mathematics, environmental education, and agritourism potential in support of participatory and sustainable learning. The programme involved identifying partner needs, mapping environmental and agritourism resources, conducting participatory discussions, assisting participants in designing contextual mathematics activities, and developing the Eco-Edu Puntondo digital platform. The programme sought to strengthen the capacity of partners and university students, produce locally grounded learning activities, and provide a digital medium for information, education, and programme documentation. Through this initiative, Eco-Edu Puntondo is expected to develop into an adaptive environmental education model that connects numeracy, local potential, technological support, and sustainability and that may be replicated in other contexts.

2. Methods

2.1. Program Design

The Eco-Edu Puntondo Community Partnership Program employed a participatory, community-based approach in which the university team and community partners collaborated in identifying needs, designing activities, developing educational products, and evaluating the programme. Throughout the PKM, university researchers, pre-service teachers, the classroom teacher, and community members engaged in continuous dialogue and reflective discussions to jointly improve the instructional design and assess the learning process. This participatory approach positioned community members as active partners who contributed local knowledge, resources, and practical experience rather than merely serving as programme recipients. It also emphasized co-learning, capacity building, equitable collaboration, and the mobilization of community strengths to address locally identified needs (Djam'an dkk, 2026b)

The development of the learning activities and digital platform was guided by an adapted ADDIE framework comprising analysis, design, development, implementation, and evaluation (Branch, 2009). The framework was applied flexibly to accommodate the characteristics, needs, and resources of PPLH Puntondo. The programme focused on integrating contextual mathematics, environmental education, and agritourism into participatory and sustainable learning activities.

2.2. Setting and Participants

The programme was conducted during the even semester of the 2025/2026 academic year at the Puntondo Environmental Education Centre (*Pusat Pendidikan Lingkungan Hidup* [PPLH] Puntondo), Takalar Regency, South Sulawesi, Indonesia. The main programme activities were conducted on July 12, 2026.

Participants included PPLH Puntondo staff, the principal and teachers of Asy-Syamsi Kindergarten, and Mathematics Education students from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar. The university students participated in field observations, environmental resource mapping, the development of contextual mathematics activities, programme documentation, and the preparation of digital learning materials. The PPLH staff and teachers contributed information about local environmental conditions, existing educational activities, participants' learning needs, and the feasibility of implementing the proposed activities.

2.3. Programme Implementation

The programme was implemented through a series of interconnected stages, as illustrated in Figure 1.



Figure 1. Stages of Community Service Program Implementation

2.3.1. Needs Assessment and Resource Mapping

The first stage involved identifying the partners' needs and mapping the environmental and agritourism resources available at PPLH Puntondo. Data were collected through field observations, informal interviews, participatory discussions, and documentation of the centre's educational facilities and environmental resources.

The needs assessment examined the existing environmental education activities, available learning facilities, participants' experience in developing contextual learning, and the extent to which mathematical concepts had been incorporated into environmental education. The resource-mapping process covered natural and built environments, agricultural activities, renewable-energy facilities, water and waste management, accommodation facilities, and other locations that could function as learning resources.

This stage indicated a need for structured educational activities connecting mathematical concepts with authentic environmental situations and for a digital platform through which learning materials and information could be organized and accessed. Consistent with the analysis phase of ADDIE, these findings provided the basis for determining programme objectives, content, activities, and expected outputs (Branch, 2009).

2.3.2. Participatory Workshop and Training

The second stage consisted of a participatory workshop designed to strengthen participants' understanding of contextual mathematics, environmental education, and sustainable agritourism. The workshop introduced strategies for transforming local environmental issues into meaningful mathematics learning activities.

Participants worked collaboratively to identify mathematical concepts embedded in the Puntondo environment. These concepts were connected to activities involving observation, measurement, experimentation, estimation, data collection and processing, comparison, pattern identification, and problem-solving. Environmental topics included waste management, water use, renewable energy, biodiversity, agricultural production, and the sustainable use of local resources.

The workshop combined short presentations, group discussions, environmental exploration, demonstrations, and collaborative activity design. Participants were encouraged to contribute their professional and contextual knowledge throughout the process, reflecting the principles of co-learning and shared decision-making in community-based programmes.

2.3.3. Development of Learning Materials and the Digital Platform

Based on the needs assessment and workshop results, the team collaboratively developed Eco-Edu Puntondo learning materials. These included contextual mathematics activities, instructional modules, environmental worksheets, visual materials, and project-based learning tasks. Each activity was organized around an environmental or agritourism context and included learning objectives, required materials, implementation procedures, relevant mathematical concepts, environmental values, and reflection or evaluation activities.

Examples of the activities included measuring environmental objects and learning areas, recording and representing environmental data, estimating resource consumption, examining renewable-energy facilities, identifying patterns in natural and agricultural environments, and solving problems associated with waste, water, and sustainable tourism.

The team also developed the Eco-Edu Puntondo digital platform as a central medium for programme information, educational content, learning modules, interactive activities, and documentation. Its development followed the design and development principles of the ADDIE framework, which emphasize alignment among identified needs, learning objectives, content, instructional strategies, and evaluation procedures (Branch, 2009). The platform was designed to support continued access to learning resources beyond face-to-face programme activities.

2.3.4. Mentoring and Initial Implementation

The fourth stage involved mentoring participants in refining and initially implementing the contextual learning activities. The university team provided pedagogical and technical assistance related to the appropriateness of mathematical concepts, clarity of instructions, relevance of environmental contexts, feasibility of activities, and use of the digital platform.

Participants reviewed the learning materials collaboratively and provided feedback based on their experience and knowledge of the local setting. Revisions were subsequently made to improve the clarity, contextual relevance, usability, and educational value of the materials. This iterative process enabled the products to be adapted to the needs of PPLH Puntondo staff, teachers, learners, and visitors.

Mathematics Education students also assisted in preparing media, facilitating environmental exploration, documenting the programme, and supporting participants during the activities. Their involvement provided practical experience in designing and facilitating contextual, community-based mathematics learning.

2.3.5. Evaluation and Follow-Up

Programme evaluation was conducted throughout the implementation process and at the completion of the main activities. It focused on participants' responses, understanding, engagement, and perceptions of the relevance and usability of the learning materials and digital platform. The evaluation was informed by the reaction and learning dimensions of the Kirkpatrick evaluation framework, which assess participants' perceptions of a programme and the knowledge or understanding developed through participation (Kirkpatrick & Kirkpatrick, 2016).

Follow-up activities included revising the learning materials, refining the digital platform, organizing programme documentation, and discussing possibilities for continued implementation. PPLH Puntondo staff and teachers were encouraged to adapt the developed activities to different participants and learning contexts. The digital platform was intended to facilitate continuing access, dissemination, and future development of the Eco-Edu Puntondo programme.

2.4. Data Collection

Data on programme implementation and outcomes were collected using the following instruments and techniques:

a. Observation sheets were used to document participants' engagement, collaboration, and involvement during discussions, environmental exploration, and learning-material development.
b. Participant questionnaires were administered to obtain information about participants' responses, perceived understanding, programme relevance, and satisfaction with the activities.
c. Interviews and participatory discussions were used to obtain feedback regarding participants' needs, experiences, perceived benefits, implementation challenges, and suggestions for improvement.
d. Product review sheets were used to assess the contextual relevance, content clarity, pedagogical appropriateness, usability, and environmental orientation of the learning materials and digital platform.
e. Documentation included photographs, field notes, developed learning activities, instructional materials, participant outputs, and records of the digital-platform development process.

The use of multiple data sources enabled the programme team to examine the implementation process and outcomes from a complementary perspective.

2.5. Data Analysis

Quantitative data obtained from the participant questionnaires and observation sheets were analyzed descriptively using frequencies, percentages, and mean scores where applicable. The results were interpreted according to the response categories established in each instrument.

Qualitative data from interviews, discussions, field notes, open-ended questionnaire responses, and programme documentation were analyzed thematically. The analysis involved familiarizing the researchers with the data, identifying meaningful statements, generating initial codes, grouping related codes into themes, reviewing the themes, and constructing an interpretive narrative of programme implementation and outcomes. This procedure was adapted from the thematic-analysis framework proposed by Braun and Clarke (2006).

The quantitative and qualitative findings were subsequently integrated to describe participants' engagement, changes in understanding, the relevance of the contextual activities, and the feasibility of using the Eco-Edu Puntondo platform to support sustainable environmental education.

3. Results and Discussion

3.1. Identification of Partners' Needs and Local Learning Resources

The initial needs assessment revealed that PPLH Puntondo possessed considerable environmental and agritourism potential that could be used as authentic learning resources. The available resources included coastal and terrestrial ecosystems, agricultural areas, renewable-energy facilities, waste-management activities, water-use systems, accommodation facilities, and several spaces for environmental education. However, these resources had not yet been systematically integrated into structured contextual mathematics activities. As part of the PKM, the project team conducted field observations and collaborative discussions with PPLH Puntondo staff, teachers, and other community partners, as shown in Figure 2.



Figure 2. Initial Needs Assessment and Stakeholder Discussions at PPLH Puntondo

Discussions with PPLH Puntondo staff and teachers of Asy-Syamsi Kindergarten also indicated that existing activities primarily emphasized general environmental awareness. Mathematical concepts embedded in these activities, such as measurement, estimation, spatial reasoning, pattern recognition, data representation, and quantitative comparison, had not been explicitly identified or organized as learning objectives. In addition, the available educational information and documentation were distributed across different sources and had not been incorporated into an integrated digital platform.

These findings demonstrate the importance of systematically mapping the educational potential of a local environment. Place-based education allows academic concepts to be connected with learners' surroundings, community experiences, and local environmental issues (Yemini et al., 2025). In the Eco-Edu Puntondo programme, the needs-assessment process did not focus solely on identifying limitations; it also identified the existing knowledge, facilities, practices, and environmental resources that could support programme development. collaborative reflection and action to understand

and improve educational practices, aligning with a strengths-based, community-participatory orientation that builds programmes around community resources and shared expertise (Kemmis & Wilkinson, 1998).

3.2. Development of Contextual Mathematics Learning Activities

One of the principal programme outcomes was the development of contextual mathematics activities based on the environmental and agritourism resources of PPLH Puntondo. The activities integrated mathematical concepts with observation, experimentation, measurement, estimation, data collection and processing, problem-solving, and exploration of the surrounding environment.

For example, environmental objects and facilities were used to introduce concepts related to length, area, perimeter, volume, proportion, geometry, and spatial reasoning. Agricultural and environmental activities provided contexts for recording, organizing, and representing data in tables and graphs. Water use, waste generation, and renewable-energy facilities offered opportunities to develop estimation, comparison, and quantitative problem-solving tasks. These activities positioned mathematics as a tool for interpreting environmental conditions and evaluating possible solutions rather than as a set of isolated calculations. Figure 3 illustrates several environmental and agritourism resources at PPLH Puntondo that were used to develop contextual mathematics learning activities.

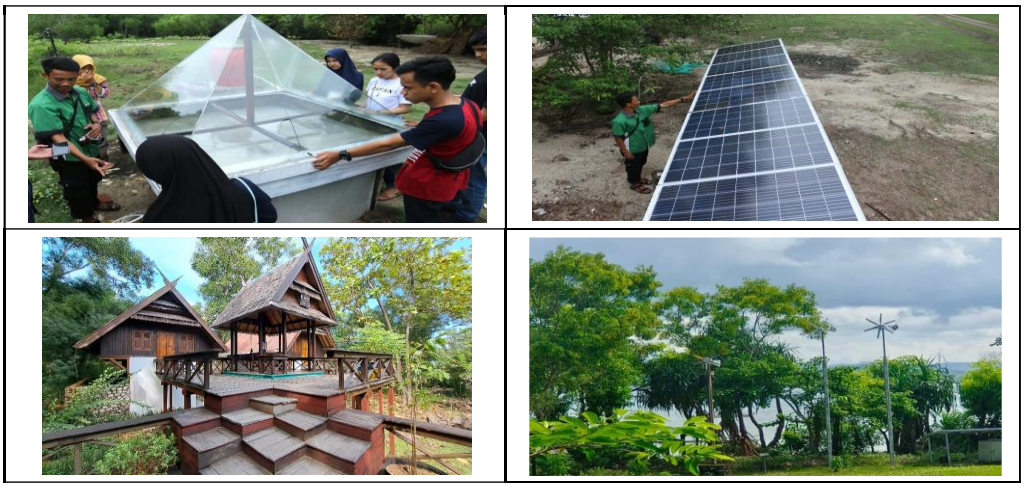

Figure 3. Environmental and Agritourism Resources at PPLH Puntondo as Contexts for Mathematics Learning

The development process also produced instructional modules, worksheets, visual learning materials, and project-based activities. Each learning activity was structured around a real environmental context and included learning objectives, relevant mathematical concepts, required materials, implementation procedures, environmental values, and reflection or evaluation tasks. This structure helped participants recognize the relationship between mathematical knowledge and environmental decision-making.

The resulting activities support the argument that mathematics education can contribute meaningfully to Education for Sustainable Development. Li and Tsai (2021) emphasized that sustainable mathematics education should move beyond abstract content by enabling learners to examine real social and environmental issues mathematically. Similarly, Vásquez et al. (2023) concluded that mathematics and statistics provide important tools for understanding sustainability challenges, particularly through measurement, data analysis, modelling, and evidence-based decision-making. Accordingly, the Eco-Edu Puntondo activities demonstrate how environmental contexts can make mathematics more relevant while simultaneously strengthening environmental awareness.

3.3. Strengthening Participants' Understanding and Capacity

Observation of the workshop and mentoring sessions indicated active engagement among PPLH Puntondo staff, teachers, and university students. Participants contributed ideas, identified environmental issues, discussed the suitability of proposed activities, and collaboratively transformed local environmental resources into contextual learning tasks. Their participation was particularly evident during environmental exploration and learning-material development. Figure 4 presents the workshop and mentoring sessions conducted to strengthen participants' understanding and capacity in contextual mathematics and environmental education.



Figure 4. Workshop and Mentoring Sessions for Strengthening Participants' Capacity

The participants demonstrated an improved ability to recognize mathematical concepts in everyday environmental activities. For example, activities that had previously been viewed primarily as environmental demonstrations were reconsidered as opportunities for mathematical observation, measurement, experimentation, and data analysis. This change was reflected in the learning activities developed by the participants and in their ability to explain connections among mathematical concepts, environmental problems, and sustainable practices.

The programme also strengthened participants' capacity to design learning that was relevant to local needs. Rather than applying generic learning materials, participants adapted the activities to the characteristics of PPLH Puntondo and its prospective learners. PPLH staff contributed practical knowledge about the environmental facilities and programmes, while teachers provided pedagogical considerations related to learners' developmental levels. University lecturers and students supported the formulation of mathematical concepts, learning objectives, activity sequences, and evaluation components.

This collaborative process illustrates the value of co-learning within community partnership programmes. Community-based approaches emphasize the reciprocal exchange of academic and contextual knowledge, capacity building, and shared ownership of programme outputs. In this programme, knowledge did not flow exclusively from the university to the community. Instead, the materials emerged from the interaction between the university team's pedagogical expertise and the partners' understanding of local environmental conditions.

Nevertheless, the reported improvement in participants' understanding should be interpreted as an immediate programme outcome. It was primarily reflected in participants' engagement, discussions, developed products, and responses during the activities. Evidence of longer-term changes in instructional practices requires follow-up observations after the materials have been implemented consistently.

3.4. Development of the Eco-Edu Puntondo Digital Platform

Another important output was the Eco-Edu Puntondo digital platform. The platform was developed as a central medium for environmental information, instructional modules, contextual mathematics activities, visual materials, interactive learning resources, and programme documentation. It was intended to improve the organization and accessibility of educational resources that had previously been distributed across different formats.

The platform's development followed an iterative process involving needs analysis, content organization, initial design, partner feedback, and revision. Input from the partners was used to improve the relevance of the content, clarity of navigation, visual presentation, and suitability of learning resources. This iterative development aligns with the ADDIE framework, which emphasizes continuous evaluation and revision throughout instructional-product development (Branch, 2009).

The digital platform expanded the programme beyond a single face-to-face activity by allowing educational materials to be accessed and developed after the initial implementation. It can also support programme dissemination, documentation, and adaptation for different groups, including teachers, students, visitors, and community members. The combination of direct environmental exploration and digital resources is particularly relevant because the platform does not replace learning in the local environment; instead, it supports preparation, documentation, reflection, and continued access to learning materials. Figure 5 presents the key features and educational resources available on the Eco-Edu Puntondo website.

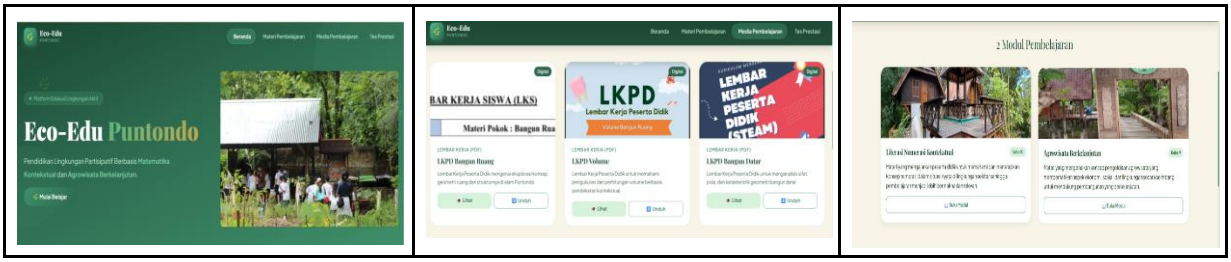

Figure 5. Features of the Eco-Edu Puntondo Website

However, the availability of a digital platform alone does not guarantee sustained use. Its long-term contribution depends on regular content updates, user accessibility, technical management, and the continued involvement of PPLH Puntondo staff. Future development should therefore include platform-use monitoring, user-experience evaluation, and the preparation of partner staff to manage and update the content independently.

3.5. Agritourism as a Context for Environmental and Mathematical Learning

The programme demonstrated that agritourism could function as more than a recreational or economic activity. The facilities and activities available at PPLH Puntondo provided opportunities for learners to examine relationships among agriculture, environmental conservation, resource use, tourism, and community development.

Agritourism activities can support mathematics learning through the calculation of land area, estimation of agricultural production, analysis of visitor numbers, comparison of resource consumption, determination of operational costs, and interpretation of environmental data. At the same time, these activities can develop awareness of how tourism and agricultural practices affect ecosystems and community sustainability. the initial needs-assessment activities and stakeholder discussions conducted at PPLH Puntondo. Figure 6 presents the resources and facilities at PPLH Puntondo that were integrated into the agritourism.

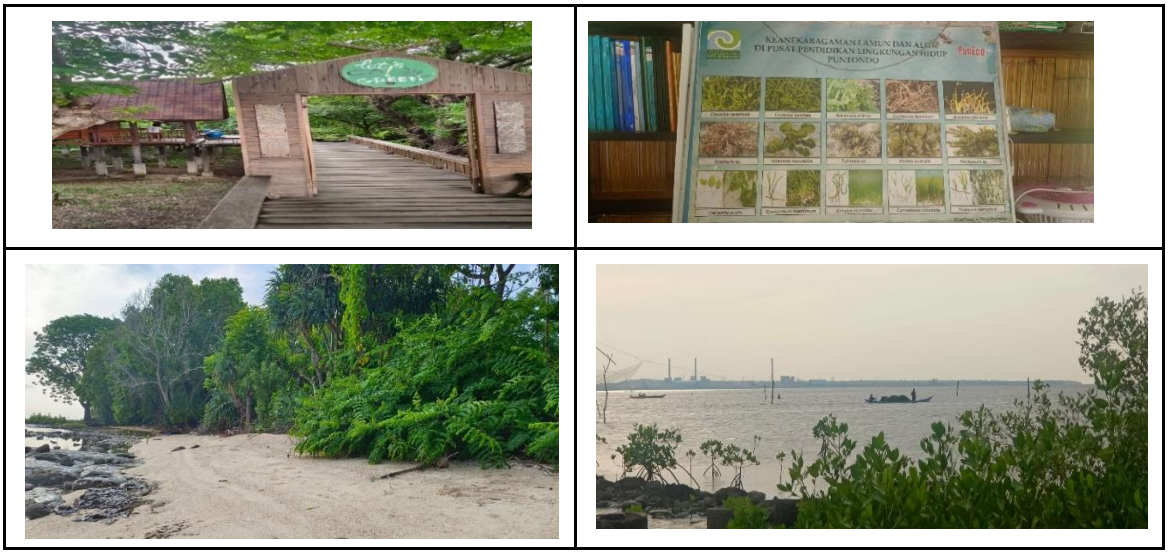

Figure 6. Agritourism Object at PPLH Puntondo

Figure 6 illustrates the assessment activities and stakeholder discussions conducted at PPLH Puntondo. These activities identified education as a key dimension of agritourism, alongside hospitality, outdoor recreation, and entertainment. Integrating agritourism with environmental education can create experiential learning opportunities that connect mathematical reasoning with authentic community-based and environmental practices. In the Eco-Edu Puntondo program, agritourism thus served as a bridge connecting academic learning, environmental responsibility, and local development.

3.6. Student Engagement and Experiential Professional Learning

The involvement of Mathematics Education students provided an additional outcome of the programme. Students participated in field observations, resource mapping, learning-material development, activity facilitation,

documentation, and digital-content preparation. Through these activities, they gained experience in applying mathematical and pedagogical knowledge outside formal classroom settings.

The local environment required students to identify mathematical concepts that were not explicitly presented as textbook problems. They had to examine environmental situations, determine their mathematical potential, formulate appropriate learning objectives, and design activities that were understandable and relevant to prospective learners. This process strengthened their ability to connect mathematical content, pedagogy, technology, and social context.

Their involvement also supported the reciprocal nature of the university–community partnership. While students contributed technological and mathematical knowledge, they learned from PPLH staff and teachers about environmental education, local resources, community needs, and the practical challenges of implementing learning activities. Such experiential professional learning can prepare prospective teachers to develop more contextual, responsive, and sustainability-oriented mathematics instruction.

3.7. Programme Sustainability and Broader Implications

The programme resulted in three interconnected outcomes: contextual mathematics learning activities, increased capacity among partners and students, and the Eco-Edu Puntondo digital platform. These outcomes provide an initial foundation for continued environmental education at PPLH Puntondo. The collaborative development process also increased the contextual relevance and potential ownership of the programme by involving partners in identifying needs, designing activities, and reviewing outputs.

The Eco-Edu Puntondo model contributes to environmental education by integrating three components that are often implemented separately: contextual mathematics, place-based environmental learning, and sustainable agritourism. This integration supports UNESCO's (2020) call for transformative learning environments, educator capacity building, youth engagement, and local action for sustainable development. It also demonstrates how numeracy can be developed through environmental issues that require learners to interpret information, analyze evidence, and make responsible decisions.

Despite these positive outcomes, several limitations should be acknowledged. The evaluation primarily examined immediate responses, participation, perceived understanding, and the products developed during the programme. It did not measure the long-term implementation of the materials, changes in participants' instructional practices, or effects on learners' mathematical achievement and environmental behaviour. Furthermore, the programme was implemented within one environmental education centre, limiting the direct generalization of its outcomes to other contexts.

Future activities should include longitudinal monitoring, classroom or field-based implementation, pre- and post-assessment of numeracy and environmental literacy, evaluation of the digital platform's usability, and documentation of changes in participants' teaching practices. Testing the programme with different age groups and environmental settings would also provide stronger evidence regarding its adaptability and replicability.

Overall, Eco-Edu Puntondo demonstrates the potential of a participatory community partnership to transform local environmental and agritourism resources into meaningful mathematics learning opportunities. The programme provides a practical model for connecting numeracy, environmental awareness, digital learning, and sustainable local development.

4. Conclusion

The Eco-Edu Puntondo Community Partnership Program demonstrated that contextual mathematics, environmental education, and agritourism can be integrated into participatory and sustainability-oriented learning. Through needs assessment, resource mapping, workshops, collaborative development, mentoring, and evaluation, the programme transformed the environmental and agritourism resources of PPLH Puntondo into meaningful contexts for mathematical observation, experimentation, measurement, data analysis, and problem-solving.

The programme produced contextual learning activities, instructional materials, and the Eco-Edu Puntondo digital platform while strengthening the capacity of PPLH staff, teachers, and Mathematics Education students to design learning experiences relevant to everyday life. The collaboration between the university and community partners also facilitated the reciprocal exchange of pedagogical expertise and local environmental knowledge.

Although the evaluation primarily captured immediate outcomes, Eco-Edu Puntondo provides a promising foundation for a locally grounded environmental education model. Future programmes should examine its long-term implementation, effects on learners' numeracy and environmental literacy, changes in participants' instructional

practices, and the usability of the digital platform. With continued partner involvement and systematic evaluation, this model could be adapted and replicated in other environmental education and agritourism settings.

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