From Waste to Learning: Utilizing Agroforestry Biomass from KHDTK Pujon Hill in Mushroom Cultivation Workshops for Elementary Schools

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ABSTRACT

This community service program was conducted in partnership with SDN Bendosari 1, an elementary school directly adjacent to KHDTK Pujon Hill, Malang, East Java. The program aimed to foster environmental awareness and skills among students through a workshop on mushroom cultivation—specifically Oyster Mushroom (*Pleurotus ostreatus*) and Button Mushroom (*Agaricus bisporus*)—using locally available agroforestry biomass waste as the main substrate. The methodology included survey and licensing, socialization, thematic environmental education sessions, practical training in making baglogs (for oyster mushrooms) and compost–casing (for button mushrooms), as well as evaluation through pretest–posttest and weekly quizzes. Results showed a significant improvement in student comprehension (correct answers in weekly quizzes increased from 15.6% in week 1 to 93.8% in week 4). Oyster mushrooms (pink and grey varieties) successfully fruited, while button mushrooms failed to produce fruiting bodies, although mycelium growth was observed. The discussion highlights success factors (availability of waste materials, suitability of simple cultivation technology, and school support) and constraints (composting protocol, casing layer quality, and microclimate control), followed by recommendations for improvement.

Introduction

SDN Bendosari 1 is an elementary school located in Tretes Hamlet, Bendosari Village, Pujon Subdistrict, Malang Regency, East Java. The school is directly adjacent to KHDTK Pujon Hill, a Kawasan Hutan dengan Tujuan Khusus (Special Purpose Forest Area) managed by the Faculty of Agriculture and Animal Science, Universitas Muhammadiyah Malang (UMM), serving as a center for education, forest protection, and hydrological functions.

As the nearest educational institution to KHDTK, SD Bendosari 1 plays a strategic role in shaping the environmental awareness of children from forest-adjacent communities. Early exposure is crucial for fostering responsible future generations capable of contributing to forest conservation.

Currently, SDN Bendosari 1 has 51 students across grades 1–6 with limited facilities: six classrooms, a teachers' office, and a principal's office, but no laboratory or library. The proximity to KHDTK Pujon Hill provides opportunities to use the forest as a "living laboratory" to enrich learning experiences, particularly in Environmental Education (PLH).

Environmental Education (PLH) aims to develop rational and responsible behavior towards environmental issues (Pratomo, 2009). The example as environmental education are plastic bottle recycling class projects that connect waste management (Nurfurqon et al., 2023), science lessons use videos and group discussions (Pertiwi et al., 2024), daily practices such as hygiene and classroom cleanliness into school routines (Zaenuri et al., 2019). In addition, green school initiatives and discovery learning modules foster active participation and structured exploration of sustainability issues (Budiono et al., 2022; Baharuddin et al., 2025). A thematic learning model—integrating multiple subjects to provide meaningful learning experiences—is particularly effective for elementary students. Direct interaction with natural objects provides deeper understanding than virtual learning alone (Silvia et al., 2021).

Mushroom cultivation was chosen as a practical and engaging learning activity. Oyster Mushroom (*Pleurotus ostreatus*) and Button Mushroom (*Agaricus bisporus*) are common edible fungi in forested highland ecosystems. Oyster mushrooms are widely cultivated in Indonesia (Achmad, 2012), while button mushrooms require compost-based substrates. Both species provide excellent learning material for combining environmental awareness with practical skills. Mushroom cultivation was selected because it combines environmental education with hands-on, skill-based learning that is directly relevant to students' daily lives. Unlike abstract lessons, growing mushrooms allows children to see the transformation of local agroforestry biomass waste (such as sawdust and rice straw) into valuable food products, thereby illustrating the principles of a circular economy in a simple and engaging manner. This activity also connects with previous environmental education programs such as waste recycling or green school initiatives by extending the idea of turning waste into useful resources and reinforcing sustainable behavior (Nurfurqon et al., 2023; Baharuddin et al., 2025). The purpose of this program is to strengthen environmental education (PLH) at SDN

Bendosari 1 by utilizing the proximity of KHDTK Pujon Hill as a living laboratory and introducing mushroom cultivation as a practical, engaging, and skill-based learning activity. Through this approach, students are expected to develop environmental awareness, understand the principles of the circular economy by converting local biomass waste into valuable products, and build responsible behaviors that support forest conservation and sustainable community practices.

Method

This community service program was carried out from April to September 2022 at SDN Bendosari 1, Tretes Hamlet, Bendosari Village, Pujon Subdistrict, Malang Regency. The activities were designed in sequential stages, beginning with a preliminary survey to assess the school's readiness, available facilities, and the potential location for mushroom cultivation, followed by obtaining official permission from school authorities. After the survey and licensing process, the program was socialized to teachers and administrators to explain the objectives, scope of activities, and expected outcomes. The next stage involved the integration of thematic environmental education into classroom sessions, where students were introduced to basic ecological concepts, forest resources around KHDTK Pujon Hill, and the importance of biomass waste utilization. Prior to practical activities, a pretest was administered to assess the students' initial knowledge and awareness regarding environmental education and mushroom cultivation.

The program involved 32 students from grades 3–6 (ages 9–12) and nine teachers. The age range of students in grades 3 to 6 was selected because they are already capable of understanding the questions and responding appropriately to the facilitator. The facilitation team comprised UMM lecturers and 10 undergraduate students under the "PMM Mitra Dosen" scheme.

The workshop component consisted of hands-on training in oyster mushroom (*Pleurotus ostreatus*) cultivation using the baglog method, and button mushroom (*Agaricus bisporus*) cultivation using compost–casing techniques. For oyster mushrooms, the procedure included substrate preparation using sawdust, bran, lime, and water, followed by composting for 2 days, bag filling, sterilization at 80–90 °C, cooling, inoculation with mushroom spawn, incubation in a controlled environment with 80–90% humidity 10 days, and fruiting until harvest 20 days. For button mushrooms, rice straw was composted with supplements of urea, ZA, and TSP at scheduled intervals, followed by pasteurization, inoculation, incubation, and the application of a 3–5 cm soil casing layer intended to trigger fruiting.

Each student was assigned to label and monitor their own cultivation unit, thereby engaging in daily care and observation. To evaluate learning outcomes, pretest and posttest questionnaires were administered, while weekly quizzes were conducted over four weeks to measure the progress of student comprehension. Practical performance was observed directly during cultivation stages, and teacher interviews were conducted to obtain qualitative insights into student learning behavior. Data were analyzed descriptively, combining quantitative indicators such as quiz scores and practice success rates with narrative observations. The program concluded with a harvesting phase, final evaluation, and dissemination of outputs in the form of a scientific article, a student booklet, and media publication.

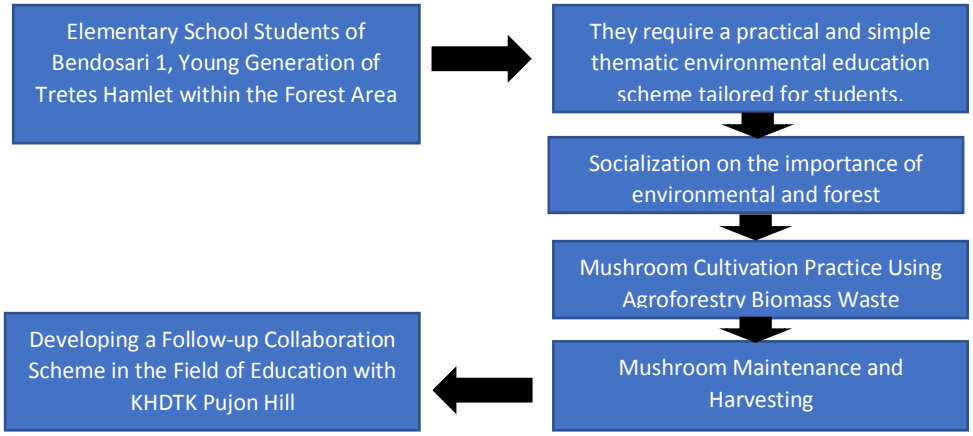

Figure 1. Community Service Activity Scheme

Results and Discussion

Results

Table 1. Student Quiz Performance (n=32)

Week	Correct Responses	Percentage
1	5 students	15.6%
2	10 students	31.3%
3	20 students	62.5%
4	30 students	93.8%

The +78.2 percentage point increase demonstrates substantial learning gains

The cultivation of oyster mushrooms showed successful results, with students able to prepare baglogs, inoculate, and maintain them until harvest of pink and grey varieties in September. The harvest matched the expected growth cycle of *Pleurotus ostreatus*, confirming that simple techniques and locally available substrates are effective and suitable for elementary-level learning. This success demonstrates that oyster mushroom cultivation provides both technical skills and visible outcomes that motivate students.

In contrast, button mushrooms only reached the stage of mycelial colonization without producing fruiting bodies. The main limitations were incomplete compost maturity and

inconsistencies in the casing layer, both of which are crucial for inducing fruiting. These results suggest that while oyster mushroom cultivation is highly appropriate for educational settings, button mushroom cultivation requires stricter process control and is less adaptable to the school context.

Overall, the contrasting outcomes highlight the importance of selecting cultivation methods that balance technical feasibility with educational objectives. Oyster mushrooms offer an accessible entry point for environmental education, while button mushrooms provide lessons about the challenges and complexities of agricultural production.

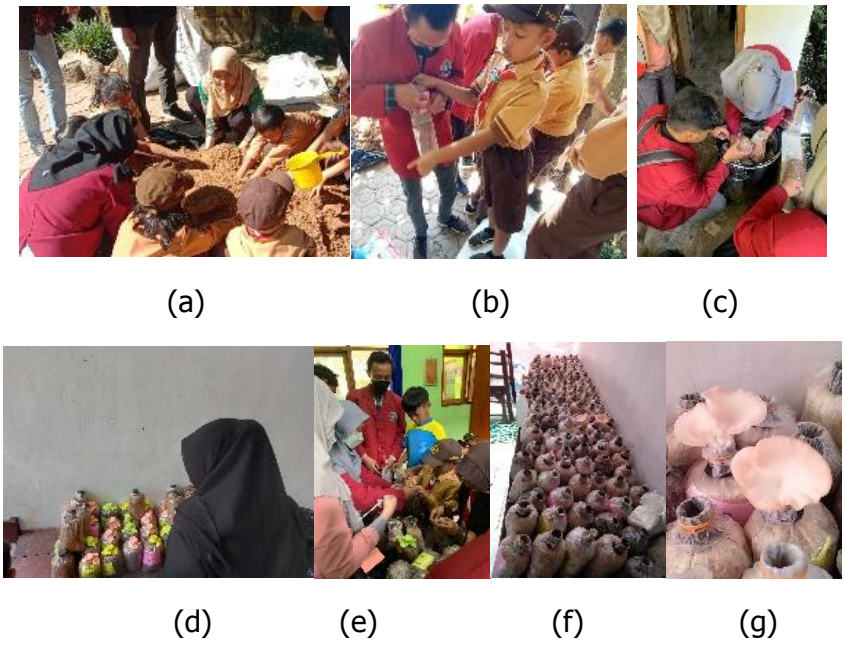

Figure 2. Students participated in practicing media preparation (a &b), media sterilization (c), cooling (d), mushroom spawn inoculation (e), incubation and maintenance (f), and harvesting the mushrooms they cultivated (g).

Discussion

The program proved effective in integrating the cognitive, psychomotor, and affective learning domains. Cognitively, students acquired new knowledge about ecosystems, waste recycling, and the biological processes of mushroom growth. Psychomotor skills were trained through hands-on activities such as substrate mixing, sterilization, inoculation, and daily maintenance of mushroom media. Affective outcomes included a sense of care for the environment, responsibility for maintaining their cultivation units, and pride in harvesting the products of their own effort. The experiential nature of cultivation provided direct observation of fungal life cycles, making abstract ecological and biological concepts more tangible. This aligns with experiential learning theory, which emphasizes learning through reflection on direct experience (Kolb, 1984). Previous studies have also shown that direct

interaction with natural objects significantly improves comprehension and retention in comparison to purely theoretical or virtual learning (Silvia et al., 2021; Rickinson et al., 2004). Thus, the integration of mushroom cultivation into environmental education proved highly effective for elementary school students.

The success of oyster mushroom cultivation can be attributed to several factors. First, the simplicity of the baglog method made it accessible to students with minimal prior experience. Baglog cultivation requires relatively straightforward steps and provides rapid, visible results, which are essential for sustaining motivation in young learners. Second, the availability of biomass waste in the form of sawdust and bran around KHDTK Pujon Hill ensured that substrates were both affordable and contextually relevant, thereby reinforcing the concept of resource recycling. Third, the local environmental conditions—including temperature (24–28 °C) and relative humidity (80–90%)—were favorable for oyster mushroom fruiting, consistent with findings from Suriawiria (2002) that *Pleurotus ostreatus* is adaptable to a wide range of tropical climates. These factors combined to create a cultivation process that was both technically feasible and educationally meaningful.

In contrast, the failure of button mushroom cultivation to produce fruiting bodies highlights the more complex requirements of *Agaricus bisporus*. Although mycelial colonization was observed, fruiting failed due to deficiencies in several critical parameters. The composting process requires precise control of microbial succession, temperature phases, and moisture to create a nutrient-rich substrate; incomplete or uneven composting can severely limit mushroom productivity (Chang & Miles, 2004). Similarly, the C/N ratio of the compost, which should ideally range between 17–20 for button mushroom cultivation, may not have been achieved, leading to nutritional imbalances (Royse et al., 2017). The casing soil, which is essential for initiating fruiting by regulating humidity and gas exchange, appeared inconsistent in thickness and structure, preventing primordia formation. Moreover, microclimate control in terms of ventilation, CO_2 regulation, and light intensity was likely inadequate, given the limitations of the school facilities. These findings underscore the technical challenges of cultivating button mushrooms in non-specialized settings and suggest the need for stricter process control and additional infrastructure if such cultivation is to be pursued in future programs.

Beyond technical outcomes, the program had broader educational and social impacts. Students and teachers displayed high levels of enthusiasm, as the cultivation process provided novel and enjoyable learning experiences. The program also introduced the concept of waste

recycling, demonstrating how agroforestry biomass, often discarded as residue, could be transformed into a valuable food resource. This not only reinforced ecological principles but also provided a model of sustainable practice. Additionally, the successful oyster mushroom harvest encouraged discussions about small-scale entrepreneurship, where students and their families considered the potential of mushroom cultivation as a supplementary income source. Such entrepreneurial perspectives align with the broader goals of community empowerment through education, as noted by Tilbury (2011), who emphasized that environmental education should also foster practical solutions and socio-economic benefits.

The success of mushroom cultivation as an environmental education activity opens opportunities for the next agenda to expand learning and community impact. First, the program can be developed into a school-based entrepreneurship initiative, where students and teachers process harvested mushrooms into food products, supporting both environmental awareness and local economic value. Second, it has the potential to be integrated with broader agroforestry education, such as composting, organic farming, and medicinal plant cultivation, making use of the resources around KHDTK Pujon Hill.

Conclusion

Environmental education, introduced as a thematic component within the school curriculum, was reflected in both cognitive and psychomotor learning domains. This was particularly evident during introductory sessions and guidance activities, where students were encouraged to engage directly with their surrounding environment as a learning context. The initiation process also fostered awareness of KHDTK Pujon Hill and introduced the concept of agroforestry as an ecological strategy to maintain environmental sustainability. Such exposure provided students with foundational understanding of forest functions and the importance of balanced land management. Furthermore, the workshop, conducted collaboratively with students, teachers, and school educators, involved practical training in mushroom cultivation using agricultural residues from agroforestry systems. This activity was met with positive responses, illustrating that experiential learning not only enhances knowledge acquisition but also nurtures environmental stewardship. The integration of practical activities with local environmental resources enabled students to internalize ecological values while simultaneously developing problem-solving and hands-on skills relevant to sustainability practices.

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