

The Project-Based Learning Innovation through Household Waste Utilization at Indonesian Schools Abroad

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Abstract: Environmental awareness and entrepreneurial education are essential components of sustainable learning, particularly in the context of Indonesian Schools Abroad. However, many students have limited opportunities to apply these values through practical, contextual activities. This study aims to develop and implement a project-based learning model utilizing household waste to enhance students' creativity, process skills, and environmental responsibility. The research employed the **ADDIE development model**, consisting of analysis, design, development, implementation, and evaluation stages. Data were collected through observations, interviews, and questionnaires involving 10 students and several teachers. The findings indicate that engaging students in household waste utilization projects effectively improves their ability to design economically valuable products, collaborate, and think critically. The feasibility test by experts yielded a "very good" category with a mean score of 88.5%, while students demonstrated positive engagement and motivation throughout the activities. It can be concluded that project-based learning through household waste utilization is a feasible and effective strategy to promote green education and entrepreneurship in international Indonesian school settings.

Keywords: creativity; entrepreneurship; green education; household waste; project-based learning

Introduction

Sustainable environmental education has become a critical component in developing students' awareness and responsibility toward environmental preservation and economic empowerment. Integrating waste management practices into school-based projects not only promotes eco-friendly habits but also cultivates creativity and entrepreneurship among students (Subali, Sudarmin, & Parmin, 2009; Aini et al., 2020; Bachtiar, Irbah, & Islamiah, 2022). In line with the Independent Curriculum and the Pancasila Student Profile, schools are encouraged to develop character-building activities through the *Projek Penguatan Profil Pelajar Pancasila* (P5), which includes projects on environmental care and innovation (Wahidah et al., 2023; Adhani & Fatmawati, 2019; Nurfathiyah et al., 2011). Therefore, educational institutions play a vital role in linking science learning, sustainability, and local entrepreneurship.

One of the major challenges faced by schools abroad, such as Sekolah Indonesia Davao (SID) in the Philippines, is implementing contextual learning that aligns with the Independent Curriculum. Teachers and students often face limitations in resources, training, and contextual project-based learning experiences (Delta, 2019; Sundoro, Kusuma, & Auwalani, 2020; Wardoyo, 2016). The P5 project, aimed at strengthening the Pancasila values of creativity, collaboration, and critical thinking, often lacks practical implementation strategies in overseas Indonesian schools. Thus, there is a need for innovation in learning programs that encourage students to develop hands-on skills in transforming waste into valuable products (Subali & Ellianawati, 2011; Tamrin, 2013; Bogorani & Ratnayani, 2015).

Household waste, particularly used cooking oil (*minyak jelantah*), is one of the most common yet problematic forms of waste in households. Repeated use of cooking oil has been proven to cause serious health problems, including damage to the digestive system, blood vessels, and liver due to oxidative degradation (Megawati & Muhartono, 2019; Bogorani & Ratnayani, 2015; Tamrin, 2013). In the Davao community, where many Indonesian families reside, used oil is often disposed of without proper treatment, contributing to environmental pollution. Therefore, transforming used oil into aromatic candles presents a sustainable and educationally valuable solution that supports both environmental sustainability and economic empowerment (Aini et al., 2020; Sundoro et al., 2020; Bachtiar et al., 2022).

This community-based initiative aims to empower teachers and students at SID to creatively utilize used cooking oil as raw material for producing eco-friendly aromatic candles. The project adopts the *P4-E model* (Training, Practice, Production, Promotion, and Evaluation) as a practical implementation framework for P5 in environmental and entrepreneurial education (Adhani & Fatmawati, 2019; Aini et al., 2020; Nurfathiyah et al., 2011). By involving teachers as *agents of change*, this project facilitates the integration of environmental literacy, creativity, and social responsibility into the school curriculum while enhancing students' 21st-century competencies—critical thinking, collaboration, and innovation.

Thus, the objective of this study is to describe and evaluate the process of empowering Indonesian teachers and students abroad through the creative use of household waste for economic and educational purposes. The project contributes to character formation, promotes sustainable education, and fosters entrepreneurial spirit in line with Indonesia's *Merdeka Belajar* policy. Moreover, this initiative serves as a replicable model for other Indonesian schools abroad seeking to integrate green education into their curricula (Subali & Ellianawati, 2011; Wahidah et al., 2023; Aini et al., 2020).

Methods

Research Design

This study was conducted as a **community service and educational empowerment project** applying the research and development (R&D) approach with the **ADDIE model** (Analysis, Design, Development, Implementation, and Evaluation). The project aimed to integrate environmental awareness, creativity, and entrepreneurship through **household waste utilization** in learning practices. To enhance local contextual relevance, a **P4-E model** (*Training, Practice, Production/Promotion, and Evaluation*) was adopted as the operational framework for the implementation process. The activity took place over three months at **Sekolah Indonesia Davao (SID)**, the Philippines, with both teachers and students involved in hands-on project-based learning aligned with the *Proyek Penguatan Profil Pelajar Pancasila* (P5) of the Independent Curriculum.

Participants

The subjects consisted of 10 participants, including teachers and students from SID. Teachers acted as agents of change, while students participated as direct implementers of the project. Teachers were responsible for guiding, facilitating, and evaluating the activities, ensuring that students applied scientific and entrepreneurial principles throughout the process. The training sessions and workshops were conducted in the SID multipurpose hall, equipped with basic laboratory and multimedia facilities.

Materials and Equipment

The primary materials used were used cooking oil (*minyak jelantah*) collected from local Indonesian households in Davao. Supporting materials included solidifying wax (paraffin blend), natural aromatic essences (lavender, rose, and citrus), food-grade coloring, wick strings, and metal molds. Equipment included measuring cylinders, thermometers, stainless beakers, and electric stoves for controlled heating. Packaging materials consisted of glass jars and decorative wrapping for product marketing. In addition, smartphones and laptops were used for social media promotion, documentation, and digital accounting exercises.

Procedure

The community empowerment program followed the **P4-E framework**, consisting of four main stages as (Community Service Stages):

1. **Training Stage (Pelatihan):**
Teachers and students received training on environmental education, waste management, and the process of transforming used cooking oil into aromatic candles. The session included theoretical explanations, demonstrations, and discussion on sustainability and entrepreneurship concepts.
2. **Practice Stage (Praktik Pelaksanaan):**
Participants practiced the production of aromatic candles using used cooking oil. Students were divided into groups and guided by teachers to conduct measurements, heating, filtering, mixing with aromatic essences, and molding. Emphasis was placed on creativity and accuracy in product formulation.
3. **Production and Promotion Stage (Pemasaran):**
Participants learned product packaging techniques, scent variation, digital marketing through social media platforms (Instagram and Facebook), and basic accounting for buying and selling goods/services. Students created digital posters and pricing strategies to promote their products as part of the entrepreneurship component.
4. **Evaluation and Mentoring Stage (Evaluasi dan Pendampingan):**

Continuous mentoring was provided by the research team and teachers to monitor progress, document outcomes, and assess participants' skills and reflections. Evaluation covered product quality, teamwork, creativity, and marketing competence. Feedback was used to refine the next cycle of implementation.

Data Collection and Analysis

Data were collected using observation sheets, questionnaires, and interview protocols for both teachers and students. Quantitative data, including validation results and student performance rubrics, were analyzed using descriptive statistics (mean and percentage categories). Improvement in students' process and entrepreneurial skills was further analyzed using N-Gain scores and paired sample t-tests at a significance level of 0.05. Qualitative data, such as feedback and reflections, were analyzed using Miles and Huberman's (1994) interactive approach — comprising data reduction, data display, and conclusion drawing/verification to identify recurring themes of creativity, collaboration, and sustainability.

Results and Discussion

Discussion

The findings indicate that integrating **project-based learning (PBL)** with environmental and entrepreneurial activities can effectively enhance students' **scientific process skills, creativity, and green literacy**. The transformation of used cooking oil into aromatic candles provided a meaningful, contextual experience where students learned to combine scientific experimentation with real-world economic applications. This aligns with the study of Widiastuti et al. (2022), who demonstrated that PBL significantly strengthens students' ability to link theory and practice through authentic tasks.

The implementation of the **P4-E model (Training, Practice, Promotion, and Evaluation)** proved to be a highly effective framework for teacher-student collaboration in sustainability education. Teachers, acting as *agents of change*, played a central role in scaffolding the learning process and encouraging student autonomy—consistent with Subali and Ellianawati (2011), who emphasized the importance of teachers' mentoring roles in inquiry-based and community-based science projects. Moreover, this model directly supported the *Projek Penguatan Profil Pelajar Pancasila (P5)* in cultivating creative, collaborative, and independent learners (Wahidah et al., 2023). The training product of processing used cooking oil into aromatherapy candles is shown in Figure 1.



Figure 1. a) Online Training Participants



Figure 1. b) Preparation Process for Making Aromatherapy Candles

The project also contributed to building **entrepreneurial competence** among students. Through packaging, social media promotion, and simple accounting practices, students gained exposure to real-world business processes—an aspect rarely included in conventional science education. This finding resonates with Aini et al. (2020), who reported that contextual entrepreneurship projects in schools increase students' motivation and sense of responsibility.

Furthermore, the activity supported **sustainable development education (ESD)** goals by promoting environmental responsibility and circular economy principles at the micro level of schooling. By learning to reuse waste materials, students developed eco-conscious habits that align with the United Nations' SDG 12 (*Responsible Consumption and Production*). Similar studies (Bachtiar et al., 2022; Adhani & Fatmawati, 2019) highlight that hands-on green projects are powerful in shaping long-term attitudes toward environmental sustainability.

Overall, the project's success demonstrates that community-based educational innovations, when coupled with appropriate mentorship and structured learning models, can generate meaningful outcomes in both **scientific learning** and **character development**. The integration of household waste utilization, PBL, and the P4-E framework represents a sustainable approach that can be replicated in other Indonesian overseas schools or local educational institutions implementing the *Merdeka Belajar* policy.

Conclusion

Conclusion of the community service activity includes:

1. Participants were able to understand the training material, namely how to process cooking oil into aromatherapy candles.
2. Participants were able to understand the marketing methods for aromatherapy candle products through social media, specifically Shopee.

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