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Optimizing STEM (Science, Technology, Engineering, And Mathematics) Learning Through The Use Of Free Nutritious Food Waste (MBG) To Produce Eco-Enzyme Bar Soap In SMPK Muder Teresa

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ABSTRAK

Pengabdian masyarakat ini bertujuan mengoptimalkan penerapan pembelajaran berbasis STEM (*Science, Technology, Engineering, and Mathematics*) dalam menangani permasalahan yang konstektual yakni permasalahan sampah organik dari Makanan Bergiz Gratid (MBG), sehingga harapannya dapat melatih keterampilan berpikir kritis, kreatif, kolaboratif, dan pemecahan masalah pada murid. Selain itu meningkatkan keterampilan peserta dalam mengolah sampah organic MBG menjadi eco-enzyme dan sabun padat eco-enzyme yang memiliki nilai guna. Metode pelaksanaan pengabdian ini berupa Sosialisasi dan implementasi pembelajaran STEM (*Science, Technology, Engineering, and Mathematics*) melalui Pemanfaatan Sampah Makanan Bergizi Gratis (MBG) Menjadi Produk Sabun Padat *Eco-enzyme.* Mitra dalam pengabdian masyarakat ini yakni SMPK Muder Teresa Kelurahan Oebufu Kecamatan Oebobo, Kota Kupang. Peserta kegiatan merupakan 5 guru IPA yang ada di SMPK Muder Teresa, serta murid kelas VII yang berjumlah 25 murid. Adapun tahapannya yakni tahap perencanaan, tahap sosialisasi, tahap implementasi pemeblajaran STEM, dan terakhir evaluasi. Kegiatan pengabdian kepada masyarakat melalui penerapan pembelajaran berbasis STEM dalam pemanfaatan sampah MBG menjadi eco-enzyme dan sabun padat berbasis eco-enzyme memperoleh hasil yang baik. Hasil tersebut menunjukkan bahwa kegiatan mampu memberikan pengalaman belajar yang kontekstual dan aplikatif dalam meningkatkan pemahaman serta pengalaman peserta dalam memanfaatkan sampah organik menjadi produk yang bernilai guna.
Kata Kunci: STEM, Sampah Makanan Bergizi Gratis, Ecoenzyme, Sabun padat

ABSTRACT

This community service initiative aims to optimize the application of STEM (Science, Technology, Engineering, and Mathematics)-based learning in addressing contextual issues—specifically, the problem of organic waste from Makanan Bergiz Gratid (MBG)—with the hope of fostering students' critical thinking, creativity, collaboration, and problem-solving skills. Additionally, it aims to improve participants' skills in processing MBG organic waste into eco-enzymes and eco-enzyme bar soap that have practical value. The implementation method for this community service project involves outreach and the implementation of STEM (Science, Technology, Engineering, and

Mathematics) learning through the utilization of "Makanan Bergizi Gratis" (MBG) food waste to produce eco-enzyme bar soap. The partner in this community service initiative was Muder Teresa Junior High School in Oebufu Village, Oebobo District, Kupang City. Participants included five science teachers from Muder Teresa Junior High School and 25 seventh-grade students. The stages of the program were planning, outreach, implementation of STEM education, and evaluation. This community service activity—which involved applying STEM-based learning to transform MBG waste into eco-enzymes and eco-enzyme-based solid soap—yielded positive results. The findings indicate that the activity successfully provided a contextual and practical learning experience, enhancing participants' understanding and hands-on experience in utilizing organic waste..
Keywords: *STEM, Free Nutritious Food Waste, Ecoenzymes, Bar Soap*

PENDAHULUAN

Food waste has become a global issue with implications for the environment, the economy, and the sustainability of the food system. Suboptimal food waste management can increase pollution and greenhouse gas emissions. Appropriate waste management approaches are needed, such as repurposing food waste into value-added products. Recent studies on food waste valorization confirm that food waste has the potential to serve as a source of bioactive compounds and can be converted into various useful products through the "waste-to-wealth" approach and the circular economy. These issues also present a challenge for the education sector to develop learning experiences that connect scientific concepts with real-world environmental problem-solving. Integrating sustainability into STEM education is considered crucial because it equips students with systemic thinking, problem-solving, innovation, and the application of technology to generate solutions to environmental challenges. Therefore, utilizing food waste from the Free Nutritious Meals (MBG) program to produce eco-enzymes—which are then developed into bar soap—can serve as a form of contextual STEM education. This approach integrates concepts from science, technology, engineering, and mathematics while promoting the application of circular economy principles and sustainability within the local context of Kupang City.

Based on the results of the problem identification at SMPK Muder Teresa, Oebufu Village, Oebobo Subdistrict, Kupang City, two interrelated priority issues were identified that need to be addressed immediately. First, the implementation of contextual STEM (Science, Technology, Engineering, and Mathematics)-based learning in the school environment has not been optimal; consequently, instruction has not fully utilized real-world problems in the surrounding environment as a learning resource to develop students' critical thinking, creativity, problem-solving, collaboration, and innovation skills. Second, the volume of organic waste generated by the Free Nutritious Meals (MBG) program has increased, yet this rise in organic waste has not been accompanied by an effective waste management system.

This situation highlights an opportunity to integrate the issue of organic waste at MBG into STEM education through activities that are practical, applicable, and solution-oriented. Utilizing this organic waste as raw material for eco-enzymes and subsequently processing it into eco-friendly bar soap can serve as an innovative alternative that not only helps reduce waste generation at school but also transforms the school environment into a contextual learning laboratory that integrates the concepts of science, technology, engineering, and mathematics in a holistic manner. The STEM approach has proven effective because it provides not only theoretical understanding but also practical experiences that foster students' collaboration, creativity, and social responsibility (Cinar et al., 2016; Kocakaya et al., 2018).

The program's implementation was also supported by various previous research findings and community service activities, which demonstrated that eco-enzyme-based organic waste processing can enhance students' knowledge, skills, and environmental awareness. Research on the use of eco-enzymes in junior high schools shows that hands-on organic waste processing activities provide effective direct learning experiences that enhance students' understanding of environmental management (Deviranty et al., 2024; Indriyanti et al., 2026). Furthermore, a project-based learning model involving the production of eco-enzymes has been shown to support the achievement of the Sustainable Development Goals (SDGs), particularly in the areas of waste reduction and quality education (Bajij et al., 2024).

The objective of this community service initiative is to optimize the application of STEM (Science, Technology, Engineering, and Mathematics)-based learning in addressing contextual issues—specifically, the problem of organic waste from Makanan Bergiz Gratid (MBG)—with the hope of fostering students' critical thinking, creativity, collaboration, and problem-solving skills. In addition, it aims to improve participants' skills in processing MBG organic waste into eco-enzymes and eco-enzyme bar soap that have practical value.

METHODS

This community service project involved promoting and implementing STEM (Science, Technology, Engineering, and Mathematics) education through the use of free nutritious food waste (MBG) to produce eco-enzyme bar soap. The partner in this community service initiative was SMPK Muder Teresa in Oebufu Village, Oebobo Subdistrict, Kupang City. The participants in this activity were five science teachers from SMPK Muder Teresa, as well as 25 seventh-grade students. The stages of this community service program were as follows:

1. Planning and Preparation Phase

   The initial phase involved field observations and coordination with school officials to identify existing issues at SMPK Mother Teresa in Oebufu Village, Oebobo Subdistrict, Kupang City. This included assessing the needs of teachers and students regarding STEM-based learning, the potential for utilizing MBG food waste, and the readiness of supporting facilities. During this phase, the activity schedule was also developed, tasks were assigned to the implementation team, materials and equipment were procured, and an In-Depth Learning Plan and student worksheets for making STEM-based eco-enzymes and solid soap were prepared.

2. Awareness and Education Phase

   This phase was conducted using interactive lectures. The objective of this phase was to provide teachers and students with a basic understanding of the STEM concept in learning; the impact of organic waste on the environment; the concept of eco-enzymes; and the process of processing food waste into products with economic value.

3. STEM Learning Implementation Phase through hands-on activities making eco-enzymes and solid soap from eco-enzymes. In this phase, model teachers from the community service team implement STEM learning with the students.

4. Evaluation Phase

   This stage is designed to measure the success of this activity and determine follow-up actions, with the hope that the activity can continue in the future. The process evaluation is conducted to assess student

engagement, the smoothness of the practical activities, and the effectiveness of the material delivery. The evaluation is carried out through questionnaires and observations during the course of the activity.

RESULT AND DISCUSSION

This community service activity was carried out successfully and smoothly. Overall, the activity helped improve teachers' understanding of STEM-based learning, and students enthusiastically participated in the STEM-based learning model by transforming free nutritious food waste (MBG) into eco-enzyme bar soap.

Planning and Preparation Phase.

The community service team first coordinated with the partner institution—in this case, Muder Teresa Junior High School in Oebufu Village, Oebobo District, Kupang City—to determine the nature of the activities, the schedule, the number of participants, and the readiness of the school's supporting facilities. This community service activity was assisted by students who comprised the community service team.

In addition, the team prepared various learning resources, such as In-Depth Learning Plans, Student Worksheets, and informational materials on STEM-based learning. The preparation of tools and materials for making eco-enzymes and bar soap was also carefully planned. To support the implementation of community service activities, the service team also prepared various tools needed to facilitate the practical process of converting MBG waste into eco-enzymes and solid soap. These tools included measuring cups, digital scales, stirrers, and other supporting equipment brought from the Biology Education Laboratory at the Faculty of Teacher Training and Education (FKIP), Nusa Cendana University. The service team provided these tools because the partner school did not yet have adequate laboratory facilities and equipment—it lacked even the basic laboratory tools needed to support practical activities. Thus, borrowing and utilizing equipment from the Biology Education Laboratory at the Faculty of Teacher Training and Education (FKIP) of Nusa Cendana University served as a form of technical support to ensure the activities could be carried out effectively, safely, and in accordance with STEM-based learning stages.

Education Phase.

The activities were conducted using a participatory and interactive approach, placing students at the center and as the primary agents in the learning process. The event began with opening remarks from school representatives and the community service team as a gesture of appreciation for the collaboration that has been established between the two parties. Next, participants received instructional material through an interactive lecture covering STEM-based learning, the basic concepts of organic waste—specifically Free Nutritious Food (MBG) waste—and the importance of proper waste management through the use of eco-enzymes as an alternative method for processing organic waste. The session also covered the use of eco-enzymes to make bar soap.



Figure 01. Outreach on STEM-Based Learning and MBG Waste Management

Implementation Phase of STEM Learning through the practice of making eco-enzymes and solid soap from eco-enzymes.

In this phase, the model teacher plays a role in implementing STEM-based learning examples for students. The model teacher conducts the learning process using the STEM-based Project-Oriented Problem-Based Learning (PoPBL) model that has been designed and prepared by the service-learning team. The implementation of the learning process refers to the In-Depth Learning Plan (RPM) and Student Worksheets (LKM) that were previously developed. Through these activities, students are actively engaged in identifying the problem of MBG organic waste, designing solutions, and carrying out a project to process the waste into eco-enzymes and eco-enzyme bar soap. This implementation is expected to provide a contextual learning experience while also serving as an example of teaching practices that teachers can replicate in their classroom activities.

The core of the STEM-based learning focused on the science aspect, where students studied the eco-enzyme fermentation process and simple chemical reactions involved in soap making. In the technology aspect, students were introduced to the use of simple tools and techniques for waste processing. In the engineering aspect, students were trained to design and produce eco-enzyme bar soap. Meanwhile, in the mathematics aspect, students practiced calculating ingredient compositions and measurements in the production process.



Figure 02. Implementation of STEM in the Production of Ecoenzymes and Solid Soap Made from Ecoenzymes

Evaluation Phase

The final stage in the implementation of community service activities is the evaluation stage. The evaluation is conducted to determine the participants' level of understanding, skills, and responses after completing the entire series of activities. The evaluation process involves direct observation during the activities as well as assessments using questionnaires. The evaluation instruments cover several aspects, including understanding of STEM-based learning materials, the utilization of MBG waste, skills in making eco-enzymes, skills in making solid soap based on eco-enzymes, and participants' level of satisfaction with the implementation of the community service activities.

Table 5. Percentage of Questionnaire Results

No	Aspect	Percentage
1	Understanding of STEM-based learning materials	86%
2	Utilization of MBG waste	89%
3	Skills in making eco-enzymes	83%
4	Skills in making solid soap using eco-enzymes	81%
5	Participants' level of satisfaction with the implementation of the activity	91%

Based on the table showing the percentage results of the questionnaire regarding these five aspects, the scores obtained were high across all aspects. The application of STEM is relevant because participants not only learned about waste management concepts but also engaged in the process of identifying organic materials, determining material composition, processing materials through fermentation, and designing a product in the form of soap. Thus, the activity provides a learning experience that connects concepts to environmental issues in the participants' immediate surroundings. This approach aligns with community service activities that utilize eco-enzymes as a project-based learning object (Marhamah et al., 2026).

The utilization of organic waste through eco-enzyme production can serve as a form of community-based waste management. Setiati et al. (2024), for example, demonstrated that training in the processing of organic waste into compost and eco-enzymes can enhance the community's skills in utilizing organic waste that was previously simply discarded. Similar results were also reported by Agustina et al. (2024) through training activities on eco-enzyme production in a school setting. These activities involved teachers and students in utilizing fruit and vegetable scraps to produce eco-enzymes. These findings demonstrate that organic waste processing through hands-on activities can be applied in the context of education and environmental empowerment.

Soap-making is a process that requires greater precision than activities involving the identification and utilization of organic waste. Participants need to understand the function of each ingredient, measure ingredients accurately, follow the mixing sequence, and adhere to safety procedures throughout the production process. Therefore, developing soap-making skills requires more intensive hands-on practice and guidance. According to Mardiyanti et al. (2026), a study on education and training

in the production of eco-enzyme-based eco-dish soap showed that participants experienced an increase in knowledge after the activity and acquired practical skills in producing more environmentally friendly cleaning products.

Ultimately, the participants were satisfied with the implementation of this community service activity. The high level of satisfaction indicates that, in general, participants responded positively to the program. This satisfaction may be related to the relevance of the material, the hands-on approach, participant engagement, guidance provided during the activity, and the opportunity to create products from materials previously considered waste. These findings align with eco-enzyme-based community empowerment activities that incorporate education, interactive discussions, and hands-on practice.

Thus, this activity makes two key contributions. First, from an educational perspective, the activity provides STEM-based learning experiences through real-world problems closely related to the participants' daily lives. Second, from an environmental and empowerment perspective, the activity introduces alternative ways to utilize organic waste into products with practical value. To ensure the program's sustainability, future activities should focus on post-training mentoring, monitoring the eco-enzyme fermentation process, improving skills in making derivative products, and evaluating changes in participants' behavior regarding organic waste management. Thus, the program's success is measured not only by participants' immediate responses after the activity but also by their ability to apply their skills and maintain sustainable waste management practices.

This activity specifically supports SDG 4 (Quality Education) through the implementation of project-based STEM learning, which provides students with contextual learning experiences in solving real-world environmental problems. Through this activity, students not only gain knowledge but also develop critical thinking, creativity, problem-solving, collaboration, communication, and scientific process skills. This activity also supports SDG 12 (Responsible Consumption and Production) by repurposing food waste from the Free Nutritious Meals (MBG) program into raw materials for producing eco-enzymes, which are then processed into bar soap. This approach introduces students to the principles of waste reduction and reuse, as well as the concept of the circular economy. Furthermore, the activity contributes to SDG 13 (Climate Action) by raising students' awareness and fostering responsible behavior in managing organic waste. The implementation of the activity through collaboration between universities, schools, teachers, and students also supports SDG 17 (Partnerships for the Goals). Thus, this activity is not only focused on improving the quality of STEM education but also on fostering environmental awareness, innovation skills, and sustainable behavior starting from school age.

CONCLUSION

The community service activity—which involved applying STEM-based learning to convert MBG waste into eco-enzymes and eco-enzyme-based bar soap—yielded positive results. These results indicate that the activity successfully provided a contextual and practical learning experience, enhancing participants' understanding and hands-on experience in transforming organic waste into useful products. The skill aspect of making solid soap based on eco-enzymes received the lowest percentage, so it needs to be the focus of further mentoring and practice. Overall, this activity has the potential to support increased awareness and skills among participants in STEM-based organic waste management and can be developed through ongoing mentoring and monitoring activities.

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