Dikdimas

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Jurnal Pengabdian Kepada Masyarakat
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Student Creativity Education in Plastic Waste Processing Innovation

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Article Information:
Received November 23, 2024
Revised December 30, 2024
Accepted December 31, 2024

Keywords:
Creativity; Education, Innovation; Pancasila Students; Plastic Waste

Abstract

This community service activity aims to address environmental problems, emphasizing project-based learning, where participants are invited to solve real-world problems in their environment. The implementation of the Kurikulum Merdeka (Independent Curriculum) offers a great opportunity to utilize the Project for Strengthening Pancasila Student Profiles (P5) as a platform to encourage student involvement in environmental issues. One tangible form of P5 implementation is through a project converting plastic waste into oil. The activity was conducted at SMA Negeri 5 Kota Lhokseumawe, employing the creative education method for plastic waste processing, including education and training for teachers and students, as well as project assignments for processing plastic waste through the pyrolysis process. The results of the community service activity showed that more than 80% of respondents rated the educational activities, such as material delivery, awareness-raising, and providing new insights on plastic waste processing, as excellent. Moreover, 95% expressed satisfaction with the implementation of the plastic waste processing project via the pyrolysis process, which successfully provided educational, technical, and motivational experiences to participants. Education and the plastic waste processing project have proven to offer practical solutions that not only enhance students' knowledge and skills but also drive behavioral and attitudinal changes toward the environment.

A. Introduction

Plastic waste is one of the world's most pressing environmental challenges today. In Indonesia, this issue has become increasingly severe with the rise in plastic consumption, which is not balanced by effective waste management efforts. Data from the Ministry of Health of the Republic of Indonesia (Kemenkes RI, 2022) shows that Indonesia produces over 69 million tons of waste annually, including plastic waste. Plastics, which do not decompose easily, require hundreds of years to break down, leading to significant accumulation in landfills, water bodies, and even contaminating our soil and air.

The government and various parties have made efforts to mitigate the negative impact of plastic waste, including promoting the 3Rs (Reduce, Reuse, Recycle). However, its realization remains far from expectations, especially at the grassroots level, such as within the general community and schools. Environmental education in Indonesia tends to be theoretical, with little emphasis on practical applications that can have a direct impact on waste management. Schools, however, hold great potential as agents of change, where students can be involved in creative and innovative projects that not only educate but also develop their skills in tackling environmental challenges.

How to Cite : Setiawan, T., Suwanda, R., Anshari, S. F., Husna, N. F., & Sartika, T. (2024). Student Creativity Education in Plastic Waste Processing Innovation. *DIKDIMAS : Jurnal Pengabdian Kepada Masyarakat, 3*(3), 160–167. https://doi.org/10.58723/dikdimas.v3i3.350
ISSN : 2830-2834
Published by : Asosiasi Profesi Multimedia Indonesia

In the context of the newly implemented Kurikulum Merdeka, there is a significant opportunity to utilize the Project for Strengthening Pancasila Student Profiles (P5) as a platform to encourage student engagement in environmental issues. One concrete example of P5 implementation is the project of converting plastic waste into oil. This project not only addresses environmental issues but is also highly aligned with the goals of Kurikulum Merdeka, which emphasizes project-based learning where students are expected to solve real problems in their surroundings (Autila, 2024; Kementerian Pendidikan dan Kebudayaan (Kemdikbud), 2022).

The process of converting plastic waste into oil using pyrolysis technology is one innovation that can be introduced to high school students. This technology works by heating plastics at high temperatures in the absence of oxygen, producing oil that can be used as an alternative fuel. Studies by (Hasan et al., 2024; Kumar & Pali, 2024; Lee et al., 2024; Oufkir et al., 2024; Radhakrishnan et al., 2023; Rahman et al., 2023), show that pyrolysis not only reduces the amount of plastic waste but also creates a new, more environmentally friendly energy source. Thus, introducing this technology to students not only raises their awareness of environmental issues but also broadens their understanding of innovative technologies that can solve various energy and environmental problems in the future (Dai et al., 2024; Li et al., 2023; Yim et al., 2024).

However, implementing this project is not without challenges. One major obstacle is the lack of technical knowledge and skills among students and even teachers. In many schools, especially in underdeveloped areas, facilities and resources for conducting experiments and environmental projects are still very limited. Furthermore, the educational culture, which still heavily emphasizes rote learning and standardized tests, hampers the development of practical and creative skills among students (Sabon et al., 2018). Therefore, a comprehensive and collaborative approach involving schools, the government, and other stakeholders is needed to overcome these challenges (Purwanto et al., 2024; Rahayu et al., 2024).

In this community service activity, the primary target for implementing the plastic waste-to-oil processing project is high school students. Based on initial observations and interviews with several teachers and students at SMA Negeri 5 Kota Lhokseumawe, several fundamental problems were identified as challenges for the partners in developing this project. First, there is still a low level of environmental awareness among students. Although environmental topics have been introduced in the curriculum, their application remains theoretical and lacks practical aspects. This results in students having a limited understanding of the urgency of plastic waste management and its impact on the environment. A study conducted by (Barkatin, 2016; Jumirah et al., 2021) revealed that environmental awareness among high school students in Indonesia remains at a low level, with most students unaware of the long-term effects of plastic waste on the environment.

Second, there is a lack of supporting facilities and infrastructure in schools. Most schools in Indonesia, especially in remote areas, lack adequate laboratory equipment to conduct experiments or projects related to waste processing technology. This has become a major obstacle in implementing innovative projects such as plastic waste-to-oil processing. According to (Despriana & Rianti, 2024), this infrastructure limitation not only hinders the development of students' technical skills but also reduces their interest in science and technology.

Third, there is insufficient support and training for teachers in implementing innovative projects. Many teachers feel unconfident or lack sufficient knowledge to guide students in projects requiring advanced technical skills, such as pyrolysis. A study conducted by (Pitri, 2023) found that one of the biggest challenges in developing project-based learning in schools is the lack of training and support for teachers in implementing innovative teaching methods. This leads many teachers to opt for conventional teaching methods that are easier and more familiar, although these methods are less effective in building students' practical skills.

Fourth, there is low student engagement in environmental projects at school. Although some initiatives have been undertaken to involve students in environmental issues, student participation remains relatively low. According to (Jumirah et al., 2021), factors such as lack of interest, limited understanding, and time constraints are often cited as reasons why students are reluctant to participate in environmental projects at school. However, active student involvement in these projects is crucial for building their awareness and commitment to environmental issues.

Considering these challenges, the project on student creativity education in plastic waste processing innovation is designed to provide practical solutions that not only enhance students' knowledge and skills but also encourage changes in their attitudes and behaviors toward the environment. This project is expected

to serve as an effective model for implementing P5 in schools, where students not only learn about environmental concepts but also engage directly in activities that benefit their surrounding environment.

B. Methods

The community service activities were conducted in stages in August 2024 at SMA Negeri 5 Kota Lhokseumawe. Each stage was designed to ensure the success of the education and plastic waste-to-oil processing program through the pyrolysis method and optimal implementation for students. The stages of the activities are outlined below:

Table 1. Activity Stages

Stages	Activity Description
Socialization & Preparation	Conducting socialization with the school regarding the community service program on educating plastic waste processing into oil.
	Discussing schedules and preparations with the school.
	Establishing a coordination team with the school for smooth implementation.
Teacher and Student Training	Providing theoretical education on plastic waste processing, including converting it into oil through the pyrolysis process.
	Demonstrating the process through video presentations for teachers and students.
Pyrolysis Project Implementation	Assigning students to the plastic waste-to-oil processing project under the guidance of teachers and the community service team.
	Students collected, cleaned, and dried plastic waste before converting it to oil using simple pyrolysis reactor equipment.
Evaluation of Activities	Evaluating the effectiveness of training, project implementation, and environmental awareness among students.
	The evaluation results were submitted to the school for recommendations on future P5 programs.

C. Result and Discussion

The partners in this community service activity are high school students, who are the primary target of the plastic waste-to-oil processing project. Based on initial observations and interviews with several teachers and students at SMA Negeri 5 Kota Lhokseumawe, several fundamental issues have been identified as challenges faced by the partners in developing this project. These include the low level of environmental awareness among students, despite the fact that environmental topics have already been introduced in the curriculum. However, their implementation remains theoretical and lacks practical application, which has resulted in students having a limited understanding of the urgency of plastic waste management and its environmental impact. In addition, there is a lack of support and training for teachers to implement innovative projects, as well as low student participation in environmental projects at school. Although several initiatives have been undertaken to engage students in environmental issues, their level of participation remains relatively low.

To address these identified problems, comprehensive and integrated solutions are necessary. The proposed solutions in this community service project involve a project-based approach that focuses on developing students' practical skills and creativity in processing plastic waste into oil through the pyrolysis method. This approach not only addresses environmental issues but also fosters students' critical thinking, creativity, and collaborative skills, aligning with the objectives of the *Kurikulum Merdeka*.

In this activity, students participated as the main participants in the pyrolysis project. They were involved in every stage, from training and collecting plastic waste to the pyrolysis process. Their involvement also included group discussions, the development of innovative ideas in plastic waste processing, and project reporting. Furthermore, students were given opportunities to compete in innovation competitions related to

waste processing, which were held as part of the program. Teachers played the role of facilitators and mentors for students throughout the activity, guiding them in understanding the pyrolysis process in the project. Additionally, the school supported the initiative by providing the necessary facilities and infrastructure for the project's implementation, such as procuring simple equipment for the pyrolysis process.

The implementation of the Community Service activities took place on June 8 and June 20, 2024, at the hall (*mushola*) of SMA Negeri 5 Kota Lhokseumawe. On the first day, Tulus Setiawan, S.Pd., M.Pd.Si., delivered a presentation on "Student Creativity Education in Plastic Waste Processing Innovation as a Real Implementation of the P5 in *Kurikulum Merdeka*". This presentation was complemented by a practical demonstration to clarify the concepts discussed for the participants.

Source: (Documentation, 2024)

Figure 1. Presentation of Material on Processing Plastic Waste into Oil

On the second day, the students were directed to work on a project related to plastic waste processing. They were assigned to create simple tools and test the process of converting plastic waste into oil. After completing the project, the students presented their creations. During this activity, the participants demonstrated high enthusiasm and extraordinary motivation. The practical implementation was supervised by lecturers and students, who actively provided guidance.

Source: (Author's Documentation, 2024)
Figure 2. Presenting and Testing Plastic Waste Processing

The impact of this community service activity on the partners included increasing students' knowledge about the process of converting plastic waste into oil, enhancing their creativity in designing simple tools for the process, and fostering awareness of the importance of sustainable plastic waste management to protect the environment. The evaluation results on the effectiveness of the education, training, and implementation of the plastic waste-to-oil processing project through the pyrolysis process are presented in the following charts:

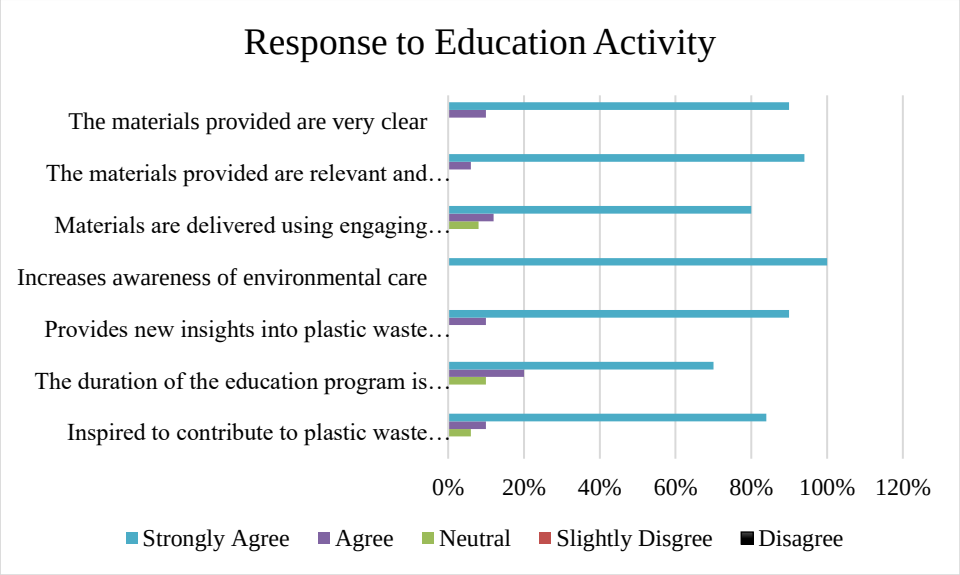

Figure 3. Chart of Responses to the Education on Plastic Waste Processing Materials

Based on the displayed chart, the educational activity successfully conveyed the material, raised awareness, and provided new insights to participants. Certain aspects, such as the duration of the activity and participants' inspiration to contribute directly, require further evaluation to enhance future activities' effectiveness. The evaluation results and analysis suggest developing more personalized methods or approaches to motivate participants to actively engage in plastic waste management.

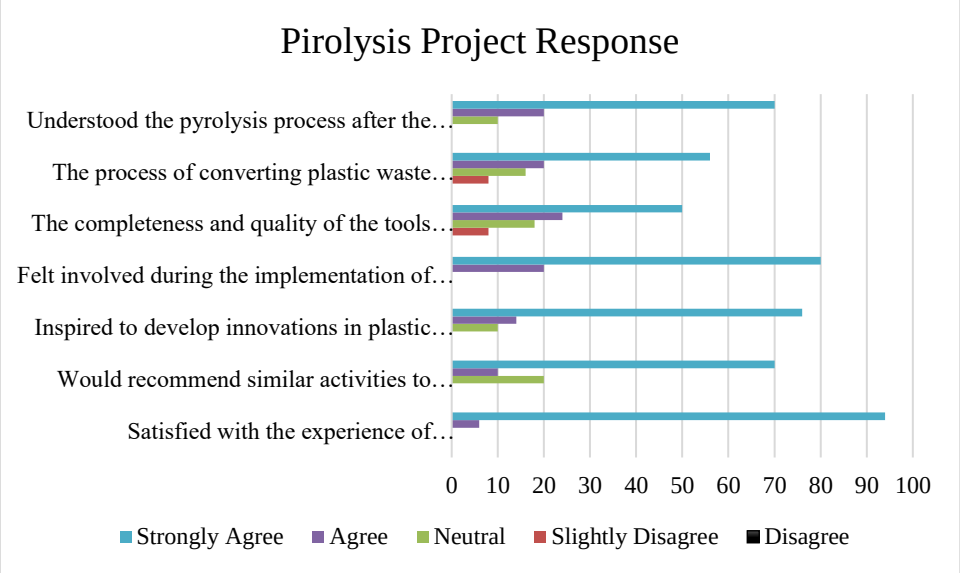

Figure 4. Chart of Responses to the Pyrolysis Project

Based on the chart showing responses to the plastic waste pyrolysis project, it can be concluded that most participants were satisfied with the activity. The majority of respondents strongly agreed on the satisfaction aspect of the project, indicating that the activity provided a positive experience. Furthermore, many participants also strongly agreed that they understood the pyrolysis process after participating in the project, showing the activity's success in increasing participants' technical knowledge.

Responses regarding the completeness and quality of the tools showed that most participants were satisfied, although a small percentage of respondents expressed doubt or disagreement. This feedback can be used to evaluate and improve the completeness and quality of the tools used to better support the project's success. Regarding participants' involvement in the project implementation, the majority felt actively involved, as reflected in the dominant responses of agree and strongly agree. This indicates that the approach used in the project successfully engaged participants to take an active role. Most participants also felt inspired to develop similar innovations and were willing to recommend the activity to others, although a small percentage expressed doubts or disagreed. This suggests that the activity had a significant impact in fostering innovation and broader participation.

The project was deemed successful in providing educational, technical, and motivational experiences to participants. However, certain aspects, such as tool quality and strategies to further motivate participants, need improvement to optimize future activities.

D. Conclusion

The process of converting plastic waste into oil through pyrolysis technology represents an innovation that can be introduced to high school students. This technology works by heating plastic at high temperatures without oxygen, producing oil that can be used as an alternative fuel. The implementation of the Community Service activity with the main theme of "Plastic Waste Processing" in collaboration with SMA Negeri 5 Kota Lhokseumawe partners was conducted successfully and achieved its intended goals and expectations. The community service team was warmly welcomed by the school principal and all participants, including teachers and students from the school.

This educational activity successfully conveyed the material, raised awareness, and provided new insights to participants. Certain aspects, such as the activity duration and participants' inspiration to contribute directly, require further evaluation to enhance future activities' effectiveness. The project's implementation was deemed successful in providing educational, technical, and motivational experiences to participants. However, aspects such as tool quality and strategies to further motivate participants need improvement to optimize future activities.

E. Acknowledgments

We extend our utmost gratitude to the entire team involved in the implementation of this community service activity, who have collaborated from the preparation stage to the final evaluation of the activity. Our deepest appreciation and thanks are also directed to our partner, SMA Negeri 5 Kota Lhokseumawe, for their enthusiastic participation in this activity, which has allowed the program to be conducted successfully and in line with its objectives and expectations.

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