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COMMUNITY EMPOWERMENT BASED ON CIRCULAR ECONOMY THROUGH THE USE OF USED COOKING OIL

Wilta Fazrina[1]*, Helen Riska Widiyawaty[2], Inasyafitri Nazihan[3], Kharisma Diastuti[4] Lu'lu' Nur Hayati[5], Meilani Fitri[6], Nila Sapti Utami[7], Nur Halisa[8], Sinarhati Wau[9], Sonia Alfi Fauziah[10]

[1-10] Universitas Terbuka, Indonesia

email: witafajrina@gmail.com [1]; helenriska01@gmail.com [2]), safitrinas02@gmail.com [3]), kharismadiastuti2306@gmail.com[4]) luluknurhayati22@gmail.com[5]) meilanifitri22@gmail.com [6]) nilasapti86@gmail.com [7]) nurhalisaa2001@gmail.com [8]) wausinarhati@gmail.com [9]) soniaalfifauziani@gmail.com [10])

* Corresponding Author

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Abstrak

Kegiatan pengabdian kepada masyarakat ini bertujuan untuk meningkatkan pengetahuan, kesadaran lingkungan, dan keterampilan masyarakat serta siswa sekolah dasar dalam mengelola minyak jelantah menjadi produk yang bernilai ekonomi melalui pendekatan ekonomi sirkular. Program dilaksanakan di Desa Waru, Kecamatan Parung, Kabupaten Bogor dan SDN Pamulang Indah, Tangerang Selatan dengan menggunakan pendekatan partisipatif berbasis Community Based Action Learning melalui metode 5-D BAGJA (Define, Discover, Dream, Design, Deliver). Kegiatan meliputi sosialisasi, Focus Group Discussion (FGD), pelatihan pembuatan lilin aromaterapi dan pupuk organik, pendampingan, serta evaluasi program. Hasil kegiatan menunjukkan adanya peningkatan pengetahuan dan kesadaran peserta mengenai bahaya minyak jelantah serta potensi pemanfaatannya sebagai produk ramah lingkungan. Sebanyak 82,9% peserta menyatakan komitmen untuk mengumpulkan dan mendaur ulang minyak jelantah, sementara 91% peserta berhasil menghasilkan produk lilin aromaterapi sesuai standar dasar kualitas. Program ini juga berhasil membentuk kelompok daur ulang lokal sebagai wadah keberlanjutan kegiatan serta mendorong integrasi pendidikan lingkungan di sekolah. Kontribusi kegiatan ini terletak pada pengembangan model pemberdayaan masyarakat berbasis ekonomi sirkular yang mengintegrasikan komunitas rumah tangga dan lembaga pendidikan dalam upaya pengelolaan limbah yang berkelanjutan, bernilai ekonomi, dan berorientasi pada pelestarian lingkungan.

***Kata kunci**: Ekonomi Sirkular; Minyak Jelantah; Pemberdayaan Masyarakat; Pendidikan Lingkungan; Lilin Aromaterapi.*

Abstract

This community service program aimed to enhance environmental awareness, knowledge, and practical skills among community members and elementary school students in transforming used cooking oil into value-added products through a circular economy approach. The program was implemented in Waru Village, Parung District, Bogor Regency, and SDN Pamulang Indah, South Tangerang, using a participatory Community Based Action Learning approach based on the 5-D BAGJA framework (Define, Discover, Dream, Design, and Deliver). The activities included educational sessions, Focus Group Discussions (FGDs), hands-on training in producing aromatherapy candles and organic fertilizer from used cooking oil, mentoring, and program evaluation. The results demonstrated significant improvements in participants' knowledge and environmental awareness regarding the hazards of improper used cooking oil disposal and its potential

economic value. A total of 82.9% of participants expressed commitment to collecting and recycling used cooking oil, while 91% successfully produced aromatherapy candles that met basic quality standards. The program also facilitated the establishment of a local recycling group to ensure sustainability and encouraged the integration of environmental education into school activities. The contribution of this program lies in developing a community empowerment model based on circular economy principles that integrates household communities and educational institutions in promoting sustainable waste management, environmental conservation, and local economic development.

Keywords: Circular Economy; Used Cooking Oil; Community Empowerment; Environmental Education; Aromatherapy Candles.

INTRODUCTION

The problem of household waste is one of the increasingly urgent environmental challenges in Indonesia, especially in densely populated urban and suburban areas (Anwar et al., 2025). One type of waste that often escapes the public's attention is used cooking oil, which is used cooking oil that has undergone changes in physical and chemical properties due to repeated heating processes (Mufida et al., 2025). Used cooking oil contains harmful compounds such as free fatty acids, peroxides, and acrylamides that are carcinogenic if re-consumed or carelessly disposed of into the environment (Suharti et al., 2025). Cooking oil consumption in Indonesia continues to increase every year in line with population growth and changes in food consumption patterns, so that the volume of used cooking oil produced by households and culinary businesses continues to increase (Wahyuni et al., 2024). The circular economy approach is relevant as a resource management paradigm that seeks to extend the life cycle of materials by recycling, reusing, and reducing waste into use-value products (Rachman et al., 2025).

Although the concept of circular economy and environment-based community empowerment has developed rapidly in the academic literature, the gap between theory and reality in the field is still very real (Mu'awwanah et al., 2024). Used cooking oil can be processed into various products of economic value such as soap, wax, biodiesel, and liquid organic fertilizers, so that this waste actually has great potential as an alternative raw material (Astuti et al., 2025). But in reality, most Indonesians, especially in rural areas and densely populated areas, still dump used cooking oil directly into waterways or soil without first treatment (Adiyono et al., 2024). This condition occurs not solely due to intentionality, but due to a lack of knowledge about the negative impact of used cooking oil on the environment and health, as well as the lack of access to simple and affordable processing technology (Kusumaningrum et al., 2025). This low environmental literacy widens the gap between the economic potential that should be achieved and the disposal practices that actually harm the ecosystem (Prasetia et al., 2025).

Departing from these problems, a concrete form of intervention is needed through community service activities that not only touch the aspect of awareness, but also equip the community with practical skills that can be directly applied

(Fauziyah et al., 2025). This activity was carried out in two target locations, namely the people of Waru Village, Parung District, Bogor Regency, and students and teachers of SDN Pamulang Indah, South Tangerang. The selection of these two locations is based on the same problem, namely low awareness and skills of used cooking oil waste management, but with different community characteristics that allow for a more contextual approach. This program is designed through a participatory and community-based 5-D approach of BAGJA (Define, Discover, Dream, Design, Deliver), with the main activities in the form of education, direct training on making aromatherapy candles and organic fertilizers from used cooking oil, and post-training assistance. Through this training, the community and students are encouraged to not only become consumers of knowledge, but to become active actors in the circular economy-based recycling movement in their environment.

A number of previous service activities have raised the theme of used cooking oil management, but most of them focus on only one aspect, for example only on the manufacture of biodiesel (Djayasinga et al., 2021), or only on socializing the dangers of used cooking oil without being followed by production training (Wijaya et al., 2023). In addition, the target of activities is generally limited to one group of adults only, without involving elements of formal education such as elementary schools (Suardi et al., 2025). This service program comes with novelty in the form of integrating two target locations at once, namely household communities and school communities, and combining two processed products at once (aromatherapy candles and organic fertilizers) in one structured training cycle. BAGJA's 5-D approach also differentiates this program from conventional service because it places the community as a reflective partner involved in each stage, not just a recipient of knowledge transfer. Thus, these activities offer a more holistic, sustainable, and replicable model of empowerment by other communities.

The main purpose of this service activity is to improve the knowledge and skills of the people of Waru Village and students of SDN Pamulang Indah in managing used cooking oil into products of economic value through a circular economy approach. In particular, this activity aims to: (1) foster environmental awareness of the dangers of indiscriminate disposal of used cooking oil; (2) equipping participants with practical skills in making aromatherapy candles and organic fertilizers; and (3) encourage the formation of local recycling groups that can become independent drivers of community economy. The contribution of this article lies in the provision of a circular economy-based service model that is integrated between household communities and basic education institutions, which is expected to be a reference for practitioners and academics in designing community empowerment programs that have a dual impact, both environmentally and economically.

METHOD

This community service activity is carried out using a participatory and educational approach based on the principle of Community Based Action Learning. This approach places the community not just as a beneficiary, but as an active subject in every stage of activities from planning, implementation, to evaluation. Through the direct involvement of the community in the entire process, this activity is expected to be able to create a pattern of empowerment that is sustainable, contextual, and relevant to local needs, so that the results can continue to be developed independently by the communities involved (McIntyre, 2008).

The subject of service consisted of two main groups, namely the people of Waru Village, Parung District, Bogor Regency as well as students and teachers of SDN Pamulang Indah, South Tangerang. In Waru Village, the activity was focused on training on the use of used cooking oil as a recycled product with economic value, considering the low level of public awareness of household waste management. Meanwhile, at SDN Pamulang Indah, the program is directed at strengthening environmental education from an early age through an eco-learning approach to form sustainable behavior. The selection of these two locations reflects efforts to address social and environmental challenges according to the characteristics of each community.

The involvement of assisted subjects is designed with the principle of collaboration between students, the community, and the school. In Waru Village, the community plays an active role in the Focus Group Discussion, which aims to identify problems and formulate solutions based on local potential. Meanwhile, at SDN Pamulang Indah, teachers and students also organize practical activities such as making aromatherapy candles and recycling simulations. Through this collaboration, this activity not only grows technical skills, but also fosters a sense of ownership, responsibility, and the spirit of mutual cooperation towards the results of the activity.

In its implementation, the service method adopts BAGJA's 5-D approach which includes Define, Discover, Dream, Design, and Deliver. Each stage is carried out systematically, starting from the identification of used cooking oil problems to the implementation of training and evaluation of results. The implementation strategy combines education, hands-on practice, and field mentoring so that participants get a holistic learning experience. The stages of the activity include preparation, socialization, training, mentoring, as well as evaluation and title of work. Through the synergy between education, participation, and real action, this method not only transfers knowledge, but also builds community capacity to be independent, making this program a social learning model that integrates leadership values, environmental innovation, and community economic empowerment.

RESULTS AND DISCUSSION

RESULT

Increasing Participants' Environmental Knowledge and Awareness

Educational activities about the dangers of used cooking oil and the concept of the circular economy were attended by 35 residents of Waru Village, most of whom are housewives and household-scale food business actors. Before the activity took place, most of the participants admitted that they still threw used cooking oil directly into waterways, empty soil, or mixed it with household waste. This condition shows the low public understanding of the environmental impact caused by used cooking oil waste. After the implementation of socialization, Focus Group Discussion (FGD), and waste treatment practices, there was a significant increase in understanding of the dangers of used cooking oil and its potential use as a product of economic value. These results are in line with the program's objectives that focus on improving environmental awareness and household waste management skills. The results of the increase between pre-test and post-test scores are described in Table 1.

Table 1. Results of Pre-test and Post-test of Waru Village Community Knowledge

No	Indicator	Pre-test	Post-test	Improvement
1	Knowledge of the dangers of used cooking oil	56,8	85,4	50,35%
2	Knowledge of the circular economy	48,2	82,1	70,33%
3	Knowledge of recycled products	52,5	87,6	66,86%
	Average	52,5	85,0	61,90%

The increase in the participants' knowledge scores after participating in a series of activities showed that the educational and participatory approach applied through the 5-D BAGJA method was able to effectively increase public understanding. In the early stages of the activity, most of the participants still had limited knowledge about the dangers of used cooking oil to health and the environment. Used cooking oil is generally considered an ordinary household waste that can be dumped into waterways or soil without causing any significant impact. In addition, the understanding of the concept of the circular economy and the economic potential of used cooking oil processing is also relatively low. This condition is reflected in the results of the pre-test which shows that most of the participants have not been able to explain the risk of environmental pollution and alternatives to using used cooking oil as a product with useful value.

Through the Define and Discover stages in the BAGJA approach, participants are invited to identify problems that occur in the surrounding environment and explore their experiences in managing household waste. This joint reflection process is an important step in building participants' initial awareness of the importance of managing used cooking oil more responsibly. Furthermore, in the Dream and Design stage, participants received various educational materials about

the negative impact of used cooking oil and opportunities to use it as raw materials for environmentally friendly products. The delivery of material is carried out interactively through discussions, questions and answers, case studies, and demonstrations so that participants not only receive information passively, but also actively participate in the learning process.

The success of increasing participants' understanding is not only influenced by the delivery of theoretical material, but also by direct involvement in practical activities. At the Deliver stage, participants were given the opportunity to process used cooking oil into aromatherapy candles and organic fertilizers independently with assistance from the service team. These practical activities allow participants to understand each stage of processing in real life so that concepts that were previously abstract become easier to understand.

The increase in knowledge that occurs then has implications for changes in the attitude and behavior of participants in managing used cooking oil. The results of the final evaluation showed that participants began to realize the importance of reducing the practice of indiscriminately disposing of used cooking oil which has the potential to pollute the soil, waterways, and surrounding ecosystems. This awareness is reflected in the increasing commitment of participants to implement more environmentally friendly waste management in their daily lives. Most of the participants expressed their willingness to collect used cooking oil in special containers before it is reprocessed or distributed to the management group that has been formed during the program.

The results of the post-activity survey showed that as many as 82.9% of participants were committed to storing used cooking oil and no longer throwing it directly into the environment. This percentage shows that the program not only succeeds in improving the cognitive aspect of knowledge, but also encourages affective and behavioral changes in participants. This change is an important indicator of the success of the program because the main goal of community empowerment does not only lie in knowledge transfer, but also in the formation of new habits that are more sustainable. Thus, this service activity succeeded in creating a transformation of understanding as well as a change in community behavior towards a more responsible, productive, and aligned household waste management practice with circular economy principles. The results of the interviews showed that there was a change in participants' awareness of the importance of household waste management.

> "Previously, I always threw used oil into the sewer because I didn't know the impact. After participating in this training, I just understood that used cooking oil can damage the environment and it turns out that it can still be used as a product that has a selling value."

The eco-learning program at SDN Pamulang Indah involved 52 students and 8 teachers. The materials provided included the dangers of environmental pollution, the concept of reduce-reuse-recycle, and the practice of using used cooking oil into aromatherapy candles. The activity is carried out using an active learning approach so that students not only receive the material theoretically but also do direct practice. This approach is in line with the program's objectives that integrate community empowerment and environmental education from an early age. The differences in students' understanding before and after the training are explained in Table 2.

Table 2. Students' Level of Understanding Before and After Eco-Learning

Indicator	Before (%)	After (%)
Knowing the dangers of used cooking oil	42,3	92,1
Understanding the concept of recycling	48,7	90,4
Knowing the economic benefits of waste	36,5	88,5
Able to explain the process of making candles	18,2	85,7

The results of the observation showed that the students were very enthusiastic about participating in the activity. They actively ask questions, engage in group discussions, and show creativity in decorating the resulting aromatherapy candle products. School teachers also provide positive support by committing to integrating waste management materials into the Pancasila Student Profile Strengthening Project (P5) activities. One of the students said:

> "I am happy because I just found out that used cooking oil can be made into fragrant candles. Later I want to try it with my parents at home."

Meanwhile, a teacher stated:

> "This activity is very relevant to form the character of caring for the environment in students. Children learn directly through practice so that the material is easier to understand and remember."

The findings from the observation and interview results show that the practice-based learning approach is able to increase the active involvement of participants in environmental education activities. The enthusiasm of the students seen through participation in discussions, the courage to ask questions, and the creativity in producing recycled products indicated that the material presented was well received. On the other hand, teachers' support to integrate waste management materials into the activities of the Pancasila Student Profile Strengthening Project (P5) shows the potential for the sustainability of the program in the school environment. Synergy between students, teachers, and service teams is an important factor in strengthening the culture of caring for the environment from an early age. Thus, this activity not only increases participants'

knowledge and skills regarding the use of used cooking oil, but also contributes to forming the character of students who are creative, responsible, and have awareness of the importance of preserving the environment through real actions in daily life.

Participant's Practical Skills in Manufacturing Recycled Products

Training in making aromatherapy candles is one of the main activities in the circular economy-based community empowerment program through the use of used cooking oil. This activity is designed to provide practical skills to participants in processing household waste into products that have use and economic value. The training is carried out through demonstration methods and direct practice in groups so that participants can understand each stage of product manufacturing in more depth. This approach was chosen to ensure that participants not only gained theoretical knowledge, but were also able to apply the skills acquired independently after the activity ended.

In the early stages of the training, participants were given an explanation of the characteristics of used cooking oil that are suitable for use as raw materials and the importance of the filtration process to remove impurities and food residues that are still contained in the oil. After that, participants were introduced to various supporting materials used in the manufacture of aromatherapy candles, such as paraffin, dyes, wax wicks, and essential oils as fragrance providers. The service team then demonstrated the steps to make candles starting from the process of mixing ingredients, heating, applying fragrance, to the correct printing techniques to produce attractive and quality products.

After the demonstration session was over, participants were divided into several groups to practice in person. During the practice process, participants showed high enthusiasm by actively following each instruction and discussing the best techniques to produce candles that have good shape and a long-lasting scent. Intensive assistance from the service team helps participants understand various obstacles that arise during the production process, such as setting heating temperatures, material composition, and wick placement so that candles can burn optimally.

The results of the evaluation showed that this training went very well. As many as 91% of participants managed to produce aromatherapy candles that met basic quality criteria, including stable shape, good texture, even aroma, and optimal burning time. These achievements show that practice-based training methods are able to effectively improve the skills of participants. In addition, most of the participants also admitted that they were more confident to repeat the production process independently at home because they had understood the stages of manufacturing thoroughly. The aromatherapy candle products produced by the participants have a variety of scents, including lavender, lemon, and lemongrass. The variety of aromas was chosen because it is easy to obtain, has

characteristics that people like, and provides a relaxation effect that can increase the selling value of the product. In terms of appearance, participants also began to show creativity by combining different colors and shapes of prints so as to produce more attractive and competitive products in the market.

More than just producing recycled products, this training provides a new understanding to participants that used cooking oil, which has been considered as waste, can actually be processed into products with economic value. This awareness is an important capital in encouraging the growth of an environmentally-based entrepreneurial spirit at the community level. With relatively low production costs and easy-to-obtain raw materials, aromatherapy candles have the potential to be developed as a household business that supports increasing family income while reducing environmental pollution. Therefore, this training not only contributes to the improvement of the technical skills of the participants, but also opens up opportunities for the development of a sustainable circular economy in the community.

As a form of final evaluation, the activity was closed with a title of work that displayed various training products. This exhibition is a means for participants to show the results of their creativity while building confidence in the abilities that have been acquired. Most of the visitors gave positive appreciation to the quality of the products produced, especially aromatherapy candles which were considered to have an attractive appearance and marketable. Waru Village Apparatus explained:

> "We did not expect that used cooking oil waste could be turned into attractive products and have economic value. This activity is very beneficial for the community."

One of the important achievements of this program is the formation of the Waru Used Cooking Recycling Group consisting of 15 residents. This group was formed as a forum for the sustainability of the program as well as a means of collecting used cooking oil from the surrounding community. The group has a simple structure consisting of a chairman, secretary, treasurer, and executive members. The group formed developed a follow-up plan in the form of collecting used cooking oil every two weeks, further training, and product marketing development through social media. In the school environment, teachers are committed to continuing the program through school used cooking bank activities and environment-based learning projects. The head of the waru village recycling group explained:

> "We agreed to continue this activity independently because the benefits are not only for the environment but can also be a business opportunity for residents."

Overall, the results of the activity showed that the circular economy-based empowerment approach through the use of used cooking oil succeeded in increasing the participants' knowledge, skills, and environmental awareness. In addition to producing products of economic value, this program also encourages the formation of new social networks in the form of local recycling groups that have the potential to maintain the sustainability of the program in the future.

Discussion

The results of the service activities show that the circular economy-based community empowerment approach through the use of used cooking oil has succeeded in increasing the knowledge, skills, and environmental awareness of participants both in the Waru Village community group and the students of SDN Pamulang Indah. The increase in knowledge scores on the pre-test and post-test results indicates that the participatory education method applied is able to transform participants' understanding of the dangers of used cooking oil and its utilization opportunities into products of economic value. These findings support the program's initial assumption that low waste management practices in the community are more due to limited knowledge and lack of access to practical skills than to low environmental awareness alone. Thus, interventions that combine education, hands-on practice, and mentoring have proven to be effective in building community capacity to manage household waste more productively.

This result strengthens the concept of a circular economy that emphasizes the importance of extending the life cycle of materials through the principles of reduce, reuse, and recycle so that waste can be converted into new resources that have economic value (Anggraeni, 2025). Used cooking oil, which was previously seen as household waste, has been successfully converted into aromatherapy wax products and organic fertilizers that have economic and environmental benefits (Nurcahyanti et al., 2023; Hutapea, et al., 2025). This transformation shows that the implementation of the circular economy at the community level can be an effective instrument to reduce environmental pollution while improving people's welfare. These findings are also in line with the view of Istiyani et al., (2025) who stated that the success of the circular economy is highly dependent on the active involvement of the community as the main actor in the resource management process.

The change in participants' behaviour demonstrated through an increased commitment to collecting and recycling used cooking oil shows that the learning process not only results in increased knowledge, but also encourages changes in attitudes and actions. These findings are in line with findings (Susanti et al., 2024) which confirm that direct experience has a stronger influence on behavior formation than lecture-based learning alone. Participants' involvement in the practice of making aromatherapy candles and organic fertilizers allows them to gain concrete experiences that strengthen understanding as well as increase

confidence to apply these skills in daily life (Nurwidiana et al., 2026). Therefore, behavioral changes that occur in participants can be seen as the result of a learning process that is reflective, participatory, and contextual.

The findings of this service activity are also in line with various empowerment programs based on used cooking oil management that have been reported in recent years. Studies (Hasibuan et al., 2025) show that training in processing used cooking oil into household products is able to increase community environmental literacy by more than 50%. Similar results were reported by (Wardani et al., 2021) who found that community involvement in practice-based training increased the chances of program sustainability compared to socialization activities that focused only on information transfer. Research (Meylani et al., 2025) also revealed that the low utilization of used cooking oil in the community is generally due to a lack of technical skills and lack of access to simple processing models. Thus, the results of this service reinforce previous findings that an applicable training approach is an important factor in encouraging changes in community behavior towards waste management.

In addition to increasing environmental awareness, this activity also resulted in an increase in participants' entrepreneurial skills through the production of aromatherapy candles and organic fertilizers. From the perspective of community economic empowerment, these results show that household waste can be an alternative source of income if managed appropriately. These findings are in line with research (Hendarto et al., 2025) which states that the development of waste-based products has great potential to support the creative economy of local communities. In fact, some recent studies show that household-based recycled products have a pretty good market opportunity due to the increasing consumer preference for eco-friendly products (Nasution et al., 2024). Therefore, this activity not only has an ecological impact but also opens up opportunities for the development of micro businesses based on the circular economy.

The involvement of elementary school students in this program also makes an important contribution to strengthening environmental education from an early age. The enthusiasm of students during the activity showed that practice-based learning methods were able to increase learning motivation and understanding of environmental issues. These findings support the research of Pristiani et al., (2025) and Aeni et al., (2024) who assert that contextual and experiential learning is more effective in shaping environmental awareness in children than conventional learning methods. In addition, the support of teachers to integrate waste management materials into the Pancasila Student Profile Strengthening Project (P5) shows that there are opportunities for program sustainability through the formal education system. This integration is a strategic step in instilling the value of environmental responsibility and sustainability to the younger generation.

Several challenges are still found in the implementation of the program, especially related to the continuity of used cooking oil collection and marketing of recycled products. Some participants still need further assistance related to packaging development, marketing strategies, and community-based business management. These findings are in line with the results of a study (Inayati et al., 2021) which states that the success of a waste treatment program is not only determined by production capability, but also by the success of building a sustainable value chain and market access. Therefore, advanced programs that focus on strengthening entrepreneurial and marketing aspects are important to ensure more optimal economic benefits for the community.

The results of this activity show that the circular economy-based community empowerment model through the use of used cooking oil has high relevance in answering the challenges of household waste management as well as strengthening the community's economy. Theoretically, these findings enrich the study of the implementation of the circular economy at the community level through participatory and experiential learning approaches. Practically, the model developed can be replicated in other communities with similar characteristics because it integrates education, skills training, mentoring, and strengthening community institutions in a series of sustainable programs.

CONCLUSIONS AND SUGGESTIONS

Circular economy-based community service activities through the use of used cooking oil carried out in Waru Village, Parung, Bogor and SDN Pamulang Indah succeeded in achieving the goals that have been set, namely increasing knowledge, environmental awareness, and participants' skills in managing used cooking oil into products with useful value and economic value. The results of the activity showed an increase in participants' understanding of the dangers of indiscriminate disposal of used cooking oil, accompanied by a change in behavior shown through a commitment to collect and recycle used cooking oil. In addition, participants successfully developed practical skills in making aromatherapy candles and organic fertilizers, as well as the formation of local recycling groups as an effort to maintain the sustainability of the program. Theoretically, these findings reinforce the view that a participatory approach that integrates education, hands-on practical experience, and community empowerment is an effective strategy in implementing the concept of the circular economy at the community level while encouraging the formation of sustainable eco-friendly behaviors.

To increase the impact and sustainability of the program, similar activities need to be carried out in a sustainable manner through collaboration between universities, local governments, schools, and communities. Further assistance is needed, especially in the aspects of business development, product packaging, digital marketing, and institutional strengthening of recycling groups so that the

products produced have higher competitiveness. In the school environment, waste management and circular economy materials can be integrated more systematically into learning activities and the Pancasila Student Profile Strengthening Project (P5) to instill environmental awareness from an early age. In addition, the next service activity is recommended to conduct a long-term evaluation of the change in participants' behavior and the resulting economic impact so that a more comprehensive picture can be obtained of the effectiveness of the circular economy-based community empowerment model.

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