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Strengthening Generation Z's Eco-literacy through the Processing of Organic Waste into Eco-Enzymes: An Actualization of an Impactful Campus

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Abstract

The environmental harm caused by the disorganized amounts of rubbish, particularly in Indonesian cities like Bukittinggi, is the basis for the significance of implementing the community service program. This buildup is directly linked to Bukittinggi's growing population each year. This community service project aims to educate Generation Z about efforts to turn organic waste into something useful and advantageous for the environment and society. Purposive sampling was employed to choose 15 members of Generation Z from Universitas Prima Nusantara Bukittinggi for this community service program, which uses a blended learning–based counseling approach. After the training, the participants were given a tool to measure their understanding of environmental issues related to turning waste into eco-enzymes, based on the WTP (Waste to Product) concept. This community service project used a set of 18 calibrated eco-literacy instruments to obtain descriptive data on the level of environmental literacy of the activity participants. The data analysis was descriptive, illustrating the dynamics of eco-literacy among participants after receiving material and demonstrations on processing waste into eco-enzymes. The results of this community service program provided students with new experiences through activities organized by the team, which demonstrated greater interest and curiosity. Environmental literacy tests showed that, overall, Generation Z participants had a high level of eco-literacy (around 66.67%), meaning that, in general, these activities have led participants to develop a deep awareness of the importance of managing waste before disposing of it in the surrounding environment. In conclusion, this training method contributes to improving environmental literacy and waste management skills for Generation Z, so that they can be empowered and continue to achieve sustainable cities.

Keywords: *Environmental Crisis; Eco-Enzyme; Waste Processing; Eco-literacy; Generation Z*

1. INTRODUCTION

Climate change and environmental problems have become very serious issues around the world. The damage to the environment is now very bad and happens in many places. One of the main reasons for this is the fast spreading of waste. Waste is a big problem in big cities. Studies show that waste is everywhere in everyday life, created at home, in work places, and in public areas (Abbass et al., 2022; Fatria, Priadi, & Apriyanti, 2025). In daily life, people cannot be separated from waste—it is generated every day at home, in offices, and in various public spaces. There is a strong link between how many people live in an area and how much waste is made; as more people move to cities, more waste is created. There is a strong link between how many people live in an area and how much waste is made; as more people move to cities, more waste is created (Sugianto, 2024). Waste is anything that people no longer need or throw away from their daily activities. It comes from homes, offices, factories, hospitals, and other places. Waste can be divided into two types: organic and inorganic. Organic waste can be broken down by nature, like food leftovers, vegetables, and fruit peels. Inorganic waste, such as plastic and

metal, does not break down easily (Fatria, Judijanto, et al., 2025). When waste gets into the soil, it takes a long time to break down, and bacteria that help break it down can create bad smells in the air (Butarbutar et al., 2024). Also, piles of waste attract pests like rats and insects. These pests can carry diseases, which spread through the soil to other animals and humans (Hadisaputro & Hernawati, 2020).

Because of the growing waste problem, there is a need for a community service program that helps people understand the environment better and learn to use waste in a useful way. This will support the idea of a Green City in Bukittinggi. The city of Bukittinggi is already dealing with a serious waste problem, as the amount of waste produced daily has surpassed the national limit. In 2021, Bukittinggi generated about 120 tons of waste per day, while the national standard allows only 0.7 kg per person. With a total population of 126,000 residents, the expected waste generation should have been around 80 tons per day (Zuhdi & Syarief, 2024). The city's population continues to grow comprising three districts and this has caused a significant increase in waste generation. Although Bukittinggi experienced a temporary population decline of 1.5% in 2019 and 7.6% in 2020, the population growth rate later increased by 0.4% annually. The rise in population driven by both natural growth and rural-to-urban migration has consequently increased waste production. Moreover, as a tourism city, Bukittinggi faces additional waste challenges due to tourism related activities. Human beings are waste producer, therefore people also need to participate in the management of waste (Azatri et al., 2024; Fatria, 2023b; Gusneli et al., 2025).

The polemic surrounding ineffective waste management is caused by the lack of firm legal frameworks provided by the government both at the regional and municipal levels combined with unmeasurable public actions (stemming from low eco-literacy) and the suboptimal management of final disposal sites (landfills) (Juaningsih & Consuello, 2021). The problem underlying this community service initiative is that waste will continue to exist and increase alongside urban population growth. Furthermore, waste management issues are compounded by inadequate processing systems and insufficient sanitation facilities and infrastructure. The low eco-literacy level of society is evident from the habit of littering, which in turn negatively affects community health and the environment (Fatria, Priadi, Artanti, et al., 2024; Murti et al., 2025).

The increasing population, variety of how people use resources, and more activities in homes have led to more waste, which is becoming more complicated to manage. Because of this, it's important for communities to learn about proper ways to handle waste and find useful ways to reuse it (Fatria, Priadi, & Fransiska, 2024; Hamidi et al., 2022). A clean and well-organized city is necessary for making life comfortable and pleasant. Having a strong economy alone is not enough if the environment is not healthy. So, city planning needs to include ideas that protect the environment, especially efficient waste management (Ardianingsih & Meliana, 2022).

Because of the many waste problems in Indonesia that are often ignored but have big effects, the community service team believes it is important to make people more aware. This is a serious issue that affects both environmental protection and the well-being of society. A zero-waste lifestyle is needed to help use resources in a circular way, turning waste into useful materials for the community (Ridwanto et al., 2023; Rustan et al., 2023). One good way to manage waste is through green innovation, like making eco-enzymes, which follow the idea of zero waste. But there is not much education or information about making eco-enzymes, especially in schools and local government areas. Because of this, people know very little about how to process organic waste (Fatria, Priadi, SN, et al., 2025).

You can make eco-enzymes at home, in a group, or by a community. It involves fermenting wet waste like fruit and vegetable peels for one to three months to create useful enzymes and good bacteria for health and the environment. Eco-enzyme products can be used in many ways, like natural cleaners and organic fertilizers, and they help save money at home (Butarbutar et al., 2024). Eco-enzyme by-products can also be used as natural remedies, detoxifiers, antiseptics, detergents, eco-friendly soaps, water purifiers, and organic fertilizers. The process is simple: mix one part brown sugar or molasses, three parts fresh fruit or vegetable waste, and ten parts water, then let it ferment in a sealed container without air (Ginting et al., 2022). Generation Z students were selected as the focus of this community service initiative due to their distinct characteristics, such as: (1) strong ambition for success; (2) practicality and speed-oriented mindset; (3) love for freedom and high self-confidence; (4) attention to detail; (5) desire for recognition; (6) multitasking skills with digital media; and (7)) strong interest in environmental issues (Fatria, 2020; Sagena et al., 2023)..

Several previous studies have shown research gaps, such as the study by Nurhidayanti et al., (2023), which states that community service in making eco-enzymes provides solutions to organic waste management problems and provides more benefits to various parties, including turning it into a business opportunity. In addition, Ginting et al., (2022) through their community service stated that eco-enzyme technology education provides an increase in community knowledge and skills about a simple, inexpensive, easy, and widely beneficial organic waste management technique. Furthermore, community service conducted by A. K. Sari et al., (2025) on eco-enzyme education for housewives has provided new knowledge about the benefits and potential of eco-enzymes as an environmentally friendly solution in organic waste management. Technical training in making eco-enzymes has also provided practical skills to housewives in making eco-enzymes, so that they can utilize organic waste into useful and valuable products. Technical training on making environmentally friendly liquid soap made from eco-enzymes has improved the ability of housewives to create environmentally friendly products in the form of eco-enzyme-based liquid soap, which can be used as a healthier alternative to commercial products for the environment. Based on the research gap above, there is no connection between education on eco-enzyme processing and the environmental literacy of participants in community service activities. Therefore, this can be used as a novelty by linking organic waste processing with the environmental literacy of participants in community service activities.

Based on innovative ideas for environmentally friendly enzyme technology in organic waste management, this community service activity aims to improve Generation Z's eco-literacy through training on converting organic waste into environmentally friendly enzymes. This is also based on the urgent need for concrete action to control the increasing volume of waste in the city of Bukittinggi. The activities carried out include lessons on how to manage organic waste and make environmentally friendly enzymes, discussions on environmentally friendly enzyme technology and its use, hands-on practice, and environmental literacy assessment using calibrated tools.

2. METHODS

The event was held at the Faculty of Science, Social, and Education Building, Campus B, of Universitas Prima Nusantara Bukittinggi. The program ran from October 2 to 7, 2025, but planning and preparation started in early September. The people who carried out this activity were lecturers from the Faculty of Science, Social, and Education, as well as the Faculty of Nursing and Public Health at Universitas Prima Nusantara Bukittinggi (UPNB). This community activity was also done with the help of Universitas Bina Sarana Informatika (UBSI), which sent lecturers as guest speakers and helped create teaching materials to improve environmental awareness by organic waste to make eco-enzymes. The goal was to reach 15 members of Generation Z.

Specifically, this community service activity consists of three stages: The Preparation Stage, where a core team for community service activities is formed through collaboration between lecturers and academics from UPNB and UBSI. After that, the team determines the problems and solutions (through FGD) conducted online and offline, which broadly highlight the volume of waste that is not properly controlled and underutilized as useful products with added value. The team sets targets and writes a community service proposal detailing the planning of organic waste management education for Generation Z, especially in facing the threat of waste if it is left to accumulate and without follow-up. The team then proceeded to obtain permits from the Community Service and Research Institute (LPPM) of each institution so that these activities could be controlled and receive assistance in providing supporting facilities and good accessibility. At this stage, an eco-literacy instrument was also developed by adopting a questionnaire with a pre-calibrated EL (Eco-Literacy) measurement scale consisting of 18 items. The questionnaire items were compiled based on conceptual and procedural definitions of eco-literacy in the form of positive and negative statements about literacy in managing organic waste into eco-enzymes in creating a sustainable urban life. The planning stage also involved creating posters or e-flyers about the importance of waste management, its impact on the environment, and promoting educational activities on eco-enzyme production to attract participants to join this activity.

The main stages are developing instructional packages on the utilization and conversion of organic waste into eco-enzymes, which consists of gathering information and materials, including a feasibility study of the location, time, and media used for the activity. The selection of instructional materials presented to participants is primarily and most importantly related to the dangers of waste and

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waste management solutions through eco-enzymes in line with the zero waste lifestyle movement. Education and training on eco-enzyme production through a blended learning strategy, which combines online (resource persons from UBSI) and offline (resource persons from UPNB) delivery of material. The material at this stage is divided into several sub-topics, namely the dangers of waste, waste management through eco-enzymes, derivative products, and the impact on the environment and society. After that, a demonstration of eco-enzyme production was carried out directly using organic waste, water, and palm sugar. The next stage was to measure eco-literacy using a prepared questionnaire and to monitor eco-enzyme products periodically between lecturers, the community service team, and students. The final stage of this activity was to document the process, analyze the collected and tabulated data in a master table, interpret the results and their meaning through descriptive statistics, and compile them into a final report.

Stages of disseminating the results of community service activities through scientific publications in reputable journals. This stage is carried out by taking several summaries from reports that have been written and developing them based on the systematic writing of journal articles. This process will go through a series of stages, such as submitting manuscripts to community service journals, being reviewed by the editorial board and reviewers, revisions, until a Letter of Acceptance (LoA) certificate can be obtained from the editorial board. The team critically assessed the selected journals (credibility and trustworthiness), particularly accredited journals. In addition, the sustainability of this community service program is also planned for the following year so that it can be taken into consideration in creating an urban environment free from the threat of waste. For further details, these stages can be described in Figure 1 below.

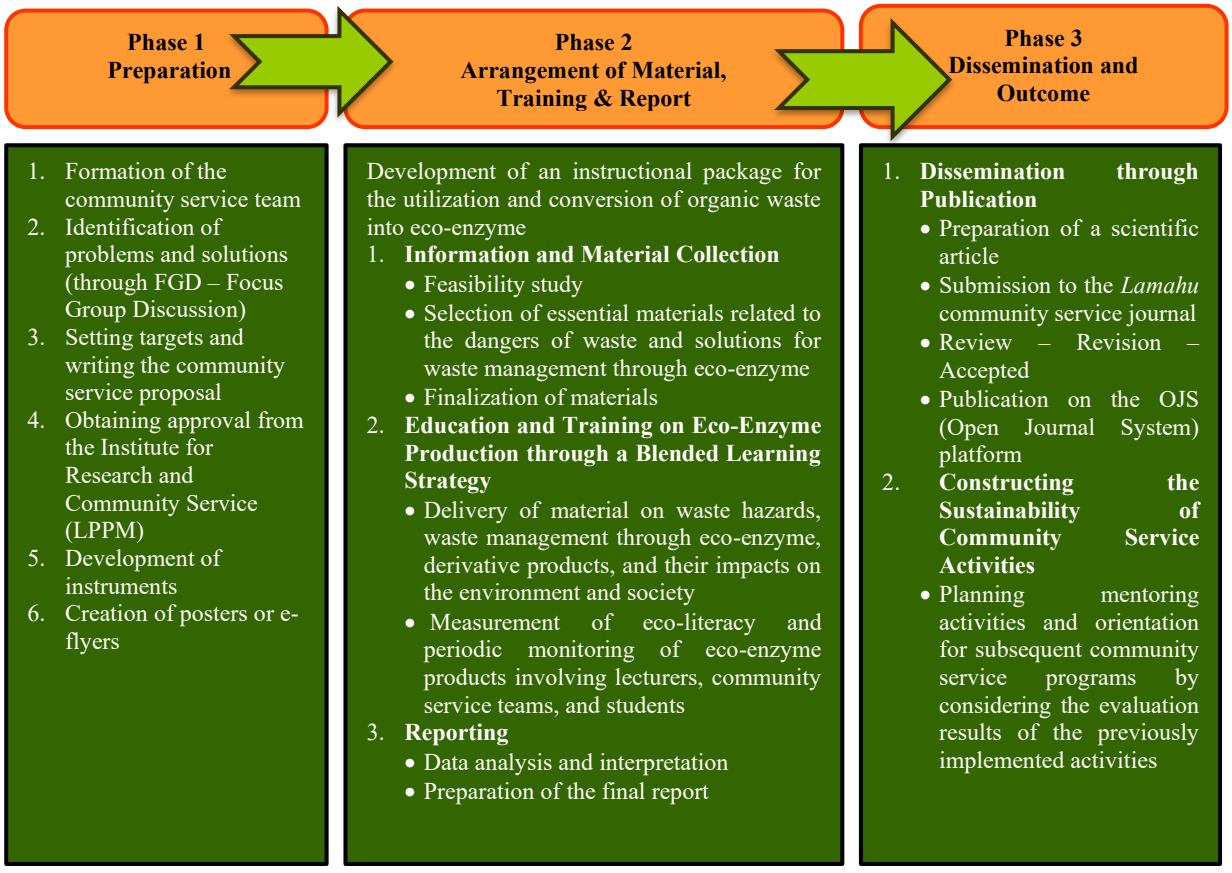

Figure 1. Community Service Activity Flow

3. RESULTS AND DISCUSSION

This community service event was meant to help young people, especially Generation Z, understand more about the environment and how to manage waste. It focused on making eco-enzymes from organic waste collected from their homes or local markets. The event was well-received and many people joined in. Most of the participants were young people who cared about how waste is handled.

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The program used a mix of in-person and online teaching. In-person sessions were led by teachers from Universitas Prima Nusantara Bukittinggi, while online sessions were conducted by lecturers from Universitas Bina Sarana Informatika, Jakarta. This approach gave participants hands-on experience and real skills in making eco-enzymes. It also helped make the campus a greener place.

The team taught about what eco-enzymes are, their benefits for health and the environment, and how they can be used at home. People had a chance to talk about their own experiences with waste. After learning about eco-enzymes, they practiced making them under the team's guidance. Before starting, they gathered all the necessary materials and tools. The main ingredients were fresh fruit and vegetable scraps, but they made sure to avoid any that were rotten or dirty. They also needed brown sugar (molasses) to help the fermentation process. The usual mix was 1 part sugar, 3 parts organic waste, and 6 parts water. The water had to be clean, which could be rainwater, bottled water, or tap water that had sat for 24 hours. The tools used included a plastic container for fermentation (glass was not recommended), a stirrer, a scale to measure the ingredients, and a strainer to separate the liquid from the leftover bits.

Figure 2. Presentation of Eco-Enzyme Material to Community Service Partners

The educational resources given to Generation Z were backed by main sources like textbooks about eco-enzymes as new ideas in environmental health and green tech, plus different scientific papers from trusted journals. These sources were picked to explain important ideas about the need for managing organic waste as a smart way to solve environmental issues in places like Bukittinggi, which is known for tourism. The goal was to help Generation Z better use what they already know about the causes of environmental damage from bad waste management by learning more about good waste practices (Fatria, Priadi, Artanti, et al., 2024). The main idea behind creating these learning materials was to design them for community service activities. These materials were based on practical and full environmental education values, focusing on how to recognize and explore positive environmental awareness, called eco-literacy. The approach aimed to explain how the skills of making eco-enzymes from organic waste are connected to the level of eco-literacy people have when dealing with environmental problems. So, environmental education is important for making good learning materials and tools for community service participants, as the main aim is to build pro-environmental knowledge and improve the quality of life (Apriyanti et al., 2025; Fatria, Judijanto, et al., 2025; Fatria, Priadi, SN, et al., 2025; Priadi & Fatria, 2024). The example of the material presented by the instructor can be seen in Figure 3 below.

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Figure 3. Eco-Enzyme Material Provided to Community Service Partners

Based on Figure 3 above, it can be explained that the development of instructional materials for this community service activity was grounded in a priority objective to achieve several points of the Sustainable Development Goals (SDGs) related to life on land, life below water, climate action, sustainable cities and communities, and responsible consumption and production. These goals were pursued through the utilization of simple green innovations, such as eco-enzymes, following the Waste to Product (WTP) concept (Setyowati et al., 2021). The instructional content specifically considered all these aspects, highlighting that transforming waste into environmentally friendly enzymes represents an innovative and sustainable strategy for responsible waste management. The community service team also conducted several online discussions on relevant topics, including the financial and environmental benefits of eco-enzyme utilization and the challenges faced in implementing this product.

By using materials on green innovation with eco-enzymes, it is hoped that Generation Z will better understand the risks of having large piles of organic waste, which can cause many problems like pollution in homes, air quality issues, and disasters related to the climate. These materials also highlight the importance of environmental economics, which is affected by the growth of eco-enzyme innovation. This innovation shows the idea that nothing should be wasted. Using household organic waste to make eco-enzymes is a very effective way to cut down the amount of waste in Indonesia, where organic waste makes up 70–90% of all garbage. Household waste is the main part of Indonesia's yearly waste, about

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64 million tons. Eco-enzyme liquid is safe for skin, natural, biodegradable, and good for the environment. Plus, it can break down and get rid of harmful microbes that are bad for health (A. K. Sari et al., 2025).

After delivering the instructional material on eco-enzyme production, the lecturer team conducted a demonstration on how to make eco-enzymes. The process began by cleaning the container thoroughly to remove any chemical residues or soap remnants, then filling it with clean water up to 60% of its capacity. Next, molasses equivalent to 10% of the water's weight was added according to the specified measurements. Afterward, pieces of raw fruits and vegetables, amounting to approximately 30% of the water's weight, were added and thoroughly mixed. The mixture was then stirred for two minutes daily during the first week, once every two days in the second week, once in the third week, and finally sealed tightly in the fourth week. The harvest and production dates were clearly labelled on each container. This demonstration activity was highly engaging for Generation Z participants, as shown by their strong enthusiasm and active participation throughout the process. Out of 15 Generation Z participants present, all were willing to practice eco-enzyme production directly after the demonstration, and 11 participants asked questions, reflecting their genuine interest in the material presented. Documentation of Generation Z involvement in this activity is presented in Figure 4 below.

Figure 4. The Process of Making Eco-Enzyme and the Results of Making Eco-Enzyme

In the final evaluation stage, the community service team conducted measurements using a calibrated eco-literacy instrument consisting of 18 items, which was administered to Generation Z participants. The measurement results were categorized into eco-literacy intervals as follows: (1) High, if the total score was above the average value; (2) Moderate, if the total score was equal to the average value; and (3) Low, if the total score was below the average value. The descriptive results of the measurement indicated that the eco-literacy levels of Generation Z participants after receiving education and a demonstration on eco-enzyme production were as follows: (1) Generation Z participants with high eco-literacy: 10 individuals (66.67%); (2) Generation Z participants with moderate eco-literacy: 1 individual (6.66%); and (3) Generation Z participants with low eco-literacy: 4 individuals (26.67%). On average, the overall eco-literacy measurement results among students were within the high interval, leading to the conclusion that the objectives of this community service program—to strengthen eco-literacy through eco-enzyme production as part of the Impactful Campus actualization initiative—were successfully achieved. These measurement results are illustrated in the bar chart (Figure 5) below. Subsequently, the findings will be reported in the official community service report and used to evaluate any shortcomings identified during the program's implementation, so that improvements can be made for future community service activities.

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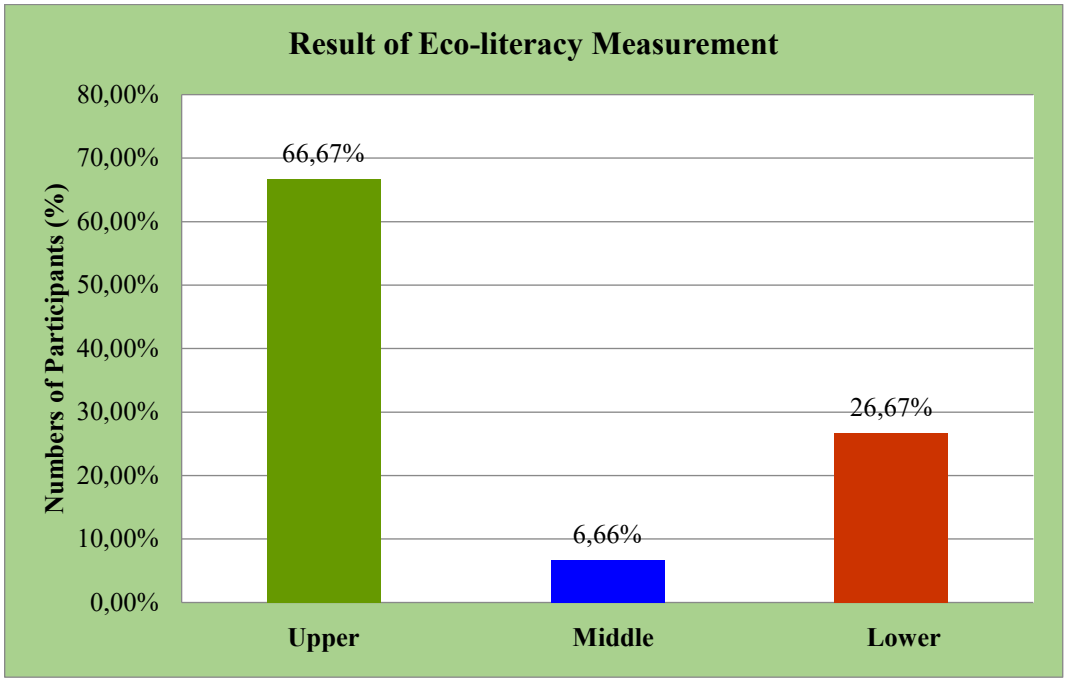

Figure 5. Generation Z Eco-Literacy Diagram about the Utilization of Organic Waste into Eco-Enzymes

Based on the results of the educational program about turning organic waste into eco-enzymes, Generation Z participants showed a big increase in their understanding of the environment. They learned how converting organic waste into eco-enzymes can help solve environmental problems caused by too much waste and its harmful effects. The community service program showed that using blended learning methods is a good way to teach Generation Z how to deal with waste issues in tourist cities like Bukittinggi. The success of this method depends on using interactive and interesting materials and tools that keep participants engaged and interested throughout the learning process. Generation Z is used to digital technology, so they like learning experiences that use educational apps and creative tools, such as Canva, to make learning materials look good and fun (Fatria, 2023a; Fatria & SN, 2024). Because of their interest in making eco-enzymes, Generation Z participants are more likely to take action to improve the environment at home. For example, they can replace chemical cleaners with eco-enzyme-based products that are better for the environment. The results of this program can also help schools in many ways, like making cleaning solutions for school buildings, eco-friendly hand soap, first-aid treatments for cuts or bruises, organic fertilizers for plants, air fresheners to reduce pollution, and eco-friendly soaps and detergents. These uses not only support environmental health but also help spread awareness about green innovations in the community and schools (Butarbutar et al., 2024).

Other studies back these findings. For example, Munir et al., (2025), found that social activities about eco-enzymes and keeping the environment clean in Bontang Kuala Village greatly improved the community's understanding. This shows that the program works well in teaching people and giving them useful skills. The knowledge they gain can be used in everyday life to help raise awareness about the environment, keep things clean, and cut down on pollution from organic waste. This program is a first step in making positive changes in the community. Also, Hakim et al., (2022), support these findings. Their research shows that through community service in Geluntung Village and at SD Negeri 1 Geluntung in Marga District, Tabanan Regency, both the villagers and elementary school kids learned more about managing organic waste using eco-enzymes. The community, which makes a lot of household waste, can turn this waste into eco-enzymes that have high value. These eco-enzymes can be used as disinfectants, natural pesticides, cleaning products, herbal medicines, and more. Making eco-enzymes can also bring in extra income for the community.

In line with the research findings above Setiawan et al., (2024) stated that the lack of proper waste disposal, particularly for household waste, is a problem that requires serious attention. One of the solutions that residents can implement to address this issue is by converting existing organic waste into eco-enzymes. To effectively manage the waste problem, it is necessary to conduct socialization and

training activities aimed at enabling community members to produce eco-enzymes. This training is considered highly appropriate, as the resulting eco-enzyme liquid can later be utilized for various derivative products.

4. CONCLUSION

Based on the results and discussions from the community service activities mentioned earlier, it can be said that the training program, which focused on turning organic waste into eco-enzymes using a blended learning approach, worked well in improving Generation Z's understanding of environmental issues. The evaluation showed that the average eco-literacy score of the participants was quite high (66.67%), which means the program's goal of increasing Eco literacy to deal with environmental problems caused by waste was met. The activities helped Generation Z participants gain valuable knowledge and skills, making them more capable of being change-makers and positive examples in their communities. The use of interactive learning tools, like Canva-based PowerPoint presentations, helped keep Generation Z students interested and involved. After taking part in this training, it is hoped that these young learners will share what they have learned with others, especially about how waste causes environmental damage, the benefits of green innovations like eco-enzymes, and how to use eco-enzyme products to support both the environment and the economy. The results from this community service program can be useful for the public and schools in understanding the importance of environmental education as part of the "Impactful Campus" effort and in working towards the Sustainable Development Goals (SDGs), specifically those related to life on land, life in the water, climate action, sustainable cities and communities, and responsible consumption and production. This study also identified several limitations, including: (1) The number of participants may have been too small and may not fully represent the Generation Z community in Bukittinggi City. (2) This study faced challenges related to the honesty of respondents in completing the eco-literacy questionnaire; some participants may have provided inaccurate answers, which could potentially cause bias. (3) The research team did not conduct an in-depth analysis of participants' environmental literacy, including at home or in their daily habits; the findings were only based on the tabulation of data collected from the research instruments filled out by the participants. (4) Many other predisposing factors that could stimulate Generation Z's eco-literacy may not have been discussed in detail due to limited funds and time constraints. Recommendations can be given to local governments, environmental and health agencies, and other academics who can use the findings of this community service activity as consideration and real solutions in dealing with the disaster of increasing waste volume and creating a quality environment. The sustainability of this program is planned by utilizing a larger community to empower their knowledge and skills in processing eco-enzyme products into derivative products that are useful, especially for agricultural activities, environmental cleanliness and health, and others.

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