MAJALAH ILMIAH JOURNAL
LPPM Universitas Putra Indonesia YPTK Padang
Jl. Raya Lubuk Begalung, Padang, West Sumatera, Indonesia, Zip Code: 25221
Volume: 32, Issue: 2, Page: 49 - 54, 08/12/2025, e-ISSN: 1412-5854
Available online at website: https://jmi-upiyptk.org/ojs/index.php/jmi/index

Eco-Trap: Environmentally Friendly Mosquito Trap from Recycled Materials to Prevent Dengue Fever

Dhito Dwi Pramardika[1]✉, Meityn Disye Kasaluhe[2], Mareike Doherty Patras[3], Nansy Delia Pangandaheng[4], Grace Angel Wuaten[5], Agneta Sartika Lalombo[6]
[1,2,3,4,5,6]Department of Health, Nusa Utara State Polytechnic, Sangihe Islands, North Sulawesi, 95812, Indonesia
Correspondence email: dhitodwi@gmail.com

Abstract

This community service program developed Eco-Trap innovation as a sustainable solution for mosquito vector control at SMA Negeri 3 Tahuna Barat. This initiative has addressed environmental health issues caused by mosquito breeding and the accumulation of plastic waste in the school environment. The implemented method combines a participatory educational approach with practical training in making mosquito traps from used plastic bottles. A total of 54 students participated in the program, which was conducted in September 2025. Evaluation using the pretest-posttest and Wilcoxon statistical analysis showed a significant increase in participants' knowledge (Z=-5.689, p=0.000) and attitude (Z=-4.534, p=0.000). This program not only succeeded in enhancing students' capacity for environmentally friendly vector control but also instilled the principles of a circular economy through the use of recycled materials. The results of the activity demonstrate the effectiveness of participatory environmental education in building ecological awareness while supporting the achievement of sustainable development goals in health and education.

Keywords: eco-trap, vector control, environmental education, student participation

1. Introduction

Mosquitoes are hematophagous insects that serve as vectors of major infectious diseases, such as dengue fever, chikungunya, malaria, and lymphatic filariasis [1,2]. Their life cycle depends on the availability of aquatic habitats for egg-laying, which are often found in small containers in domestic and institutional settings [3]. Schools are equally vulnerable to mosquito breeding in public environments. At SMA Negeri 3 Tahuna Barat, stagnant water from daily school activities, poor drainage, and unmanaged waste provide ideal breeding sites that increase the risk of dengue transmission and reduce environmental comfort.

The prevailing vector control strategy, namely the use of chemical insecticides, has led to several dilemmas. Documented consequences include insect resistance, environmental degradation, and adverse effects on human health [4]. Therefore, an environmentally sustainable approach that can reduce mosquito populations without causing harmful side effects is urgently needed. Simple innovations using recycled and locally available materials, such as plastic bottles, can be transformed into effective, low-cost mosquito traps with strong potential for adoption in school environments and integration into environmental education programs [5].

The use of discarded materials to construct mosquito traps is not merely a technical intervention, but also a strategy that integrates waste management through the application of reduce, reuse, and recycle (3R) principles [6]. This initiative has two main objectives: mitigating vector-borne health risks and minimizing plastic waste generation, which is a persistent global challenge. By directly engaging students, the program functions as a practical form of environmental education that fosters ecological awareness, creativity, and responsible resource management. Learning outcomes are multidimensional, covering the cognitive, affective, and psychomotor domains.

The program at SMA Negeri 3 Tahuna Barat aims to enhance students' capacity to recognize the risks of vector-borne diseases in their school environment and to adopt environmentally responsible behaviors. By directly engaging students in the design and implementation of Eco-Traps, the initiative fosters ecological awareness, creativity, and a sense of collective responsibility, thereby contributing to a cleaner and healthier learning environment. Active participation throughout all stages of the activity also nurtured positive social values, such as environmental awareness, teamwork, and solidarity among students.

Accepted: 20-10-2025 | Revision: 01-11-2025 | Publication: 30-11-2025 | doi: 10.35134

Conceptually, this program integrates public health, environmental ecology, and participatory education. By positioning SMA Negeri 3 Tahuna Barat as the locus of intervention, the activity demonstrated strong replicability for other educational institutions with similar environmental conditions. In addition to reducing mosquito populations, the initiative aligns with sustainable development goals related to environmental health and community empowerment. Effective collaboration among the service team, school management, and student community is a key determinant of a program's success.

2. Methods

This program is designed with a structured approach that combines educational interventions and quantitative evaluation to comprehensively measure the impact [7]. The activity stages were organized sequentially through four main interconnected phases, starting from environmental preparation to the analysis of evaluation results.

In the preparation phase, the team conducted in-depth observations of the school environment to identify locations with the potential to become mosquito breeding sites. Based on these field findings, the school was invited to collaborate to develop an implementation strategy that included determining trap placement points and scheduling activities. As support materials, the team also prepared educational modules integrated with assessment questionnaires that were developed.

The core activities of the program began with the implementation of a pre-test using a questionnaire divided into two sections. The first section consisted of four multiple-choice questions that assessed the participants' technical knowledge regarding the steps involved in making an Eco-Trap, including the correct sequence of steps, amount of materials used, function of each component, bait activation time, device's operating principle, and trapping mechanism. The second section contained four attitude statements using a Likert scale to measure participants' confidence in utilizing used goods and the effectiveness of Eco-Trap.

After the pretest, participants took part in an interactive educational session that included theoretical explanations and practical demonstrations of making Eco-Traps. The material presented was specifically designed to address the questions found in the questionnaire, thus ensuring alignment between the learning process and the evaluation instrument.

The learning process then continued with practical training, where participants directly created Eco-Traps using plastic bottles. Through structured guidance, participants not only mastered technical skills but also deepened their understanding of the biochemical principles underlying how the trap works.

The Eco-Trap is made using a 600 ml plastic bottle that is cut into two parts. The bait solution was prepared from 200 ml of warm water and 50 g of sugar and stirred until dissolution. The sugar solution was poured into the bottom part of the bottle, and then 1 g of yeast was sprinkled on its surface [8]. The top part of the bottle, which was cut, was inserted upside down to form a funnel. A black plastic wrapper was placed on the outside of the bottle to create a dark environment favored by mosquitoes. The fermentation process takes 2-3 hours to produce carbon dioxide. The CO_2 released serves as the main attractant for mosquitoes [9]. Attracted mosquitoes enter the funnel and become trapped in the solution. The finished Eco-Trap is then placed in areas around the school that are frequently used as mosquito breeding grounds.

The activity was conducted during two main periods. The coordination stage lasted for three days, including environmental observation, tool preparation, and a pre-implementation briefing with the school representatives. The main implementation phase took place in a single session on September 19, 2025, from 08.00 to 11.30 WITA, and included educational delivery, practical Eco-Trap making, and evaluation.

Program evaluation was conducted through a comparative analysis of the pre-test and post-test results. Quantitative data from the knowledge and attitude sections were analyzed using the Wilcoxon signed-rank test with IBM SPSS Statistics version 25 software.

3. Results and Discussions

A total of 54 students participated in the program, with 46 returning valid pre- and post-test questionnaires for analysis. The response rate of 85.2% reflects students' enthusiasm and active participation throughout the program.

Table 1. Wilcoxon test results for knowledge and attitude variables related to Eco-Traps (N=46)

Variable	Negative Rank	Positive Ranks	Ties	Mean Rank (+)	Z	p-value
Knowledge	1	42	3	22.4	-5.689	0.000
Attitude	4	30	12	18.7	-4.534	0.000

(Source: Field Data, 2025)

Statistical analysis using the Wilcoxon signed-rank test showed significant improvements in both knowledge ($Z = -5.689$, $p = 0.000$) and attitude ($Z = -4.534$, $p = 0.000$), confirming the effectiveness of the participatory learning approach. Specifically, 42 participants showed increased knowledge scores, while 30 demonstrated positive attitude changes toward Eco-Trap use. These findings align with previous research emphasizing that

project-based learning enhances environmental understanding and student engagement [10].

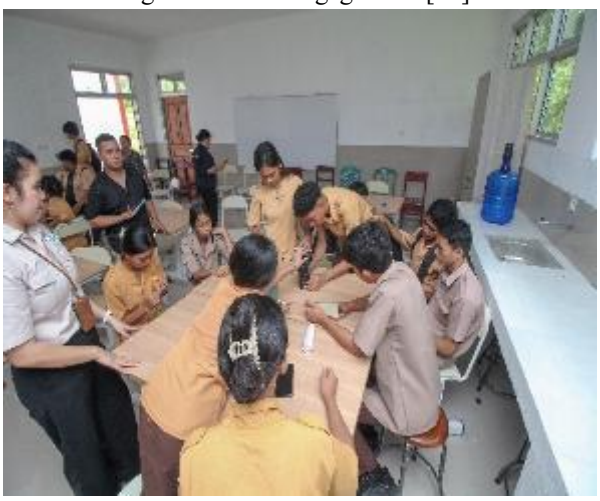

Figure 1. The process of creating Eco-Traps by the students of SMA Negeri 3 Tahuna Barat. The plastic bottles used were transformed into environmentally friendly mosquito traps by utilizing the principles of sugar and yeast fermentation.

Attitude change, although less substantial than knowledge improvement, can be explained through the theory of planned behavior, which emphasizes the influence of social norms and perceived behavioral control on behavioral change [11]. Some participants continued to rely on chemical repellents or doubted the effectiveness of Eco-Trap, illustrating the persistence of established habits. Peer influence also contributes, as individuals often conform to the opinions and behaviors of others [12]. Nevertheless, the significant Z value (-4.534, $p = 0.000$) indicates meaningful attitudinal progress overall.

Participatory and experiential learning processes proved particularly effective, as students were directly involved in constructing Eco-Traps. This hands-on experience enhanced their technical understanding of ingredient ratios and fermentation mechanisms, while reinforcing environmental values through the principles of reduce, reuse, and recycle [13,14]. Consistent with other studies, integrating cognitive, affective, and psychomotor elements is essential for achieving comprehensive learning outcomes in environmental education [15].

Several methodological considerations should be considered. The short duration of the program limited the ability to observe long-term behavioral sustainability, and the absence of a comparison group affected the external validity. Additionally, factors outside the intervention might have influenced the participants' responses [16]. As this was a limited case study, the findings should be interpreted with caution. Future studies over longer periods are needed to confirm these outcomes [17]. Integrating Eco-Trap activities into the school curriculum, with teachers serving as ongoing facilitators, could strengthen long-term impact and behavioral consistency [18,19].

This community service program makes a real contributes to improving students' knowledge of and attitudes toward environmentally friendly vector control. The significant increase in knowledge proves the effectiveness of the technical knowledge transfer method. This moderate change in attitudes reminds us of the complexity of transforming values and beliefs [20].

Figure 2. Group photo of the Community Service Team and students of SMA Negeri 3 Tahuna Barat after the implementation of the Eco-Trap program, an environmentally based vector control innovation utilizing recycled materials.

4. Conclusions

Based on the implementation of the community service program at SMA Negeri 3 Tahuna Barat, it can be concluded that an educational approach grounded in active participation effectively improves students' knowledge and attitudes toward the use of recycled materials for vector control. Statistical analysis confirmed significant improvements in both variables ($p = 0.000$). The program not only provided practical skills in constructing eco-traps but also fostered environmental awareness through the application of recycling principles. To ensure sustainability and long-term impact, integrating eco-trap activities into the school's environmental education curriculum and establishing teacher-led monitoring mechanisms are strongly recommended.

Acknowledgements

The author extends sincere appreciation to the Head of SMA Negeri 3 Tahuna Barat, along with the teachers and staff, for providing permission and facilities for the implementation of the program. We valued the active participation of all students from grades 10 to 12, who were enthusiastically involved in every stage of the activities. The authors also thank the research team for

their contributions in the preparation, implementation, and data processing. Finally, appreciation is given to various parties who cannot be mentioned individually but who have supported the success of the Eco-Trap program.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	W
Dhito Dwi Pramardika	✓	✓	✓	✓	✓	✓		✓	✓
Meityn Disye Kasaluhe						✓		✓	
Mareike Doherty Patras		✓					✓		
Nansy Delia Pangandaheng				✓					
Grace Angel Wuaten			✓		✓				
Agneta Sartika Lalombo				✓			✓		

Conflict of Interest Statement ***(mandatory)***

Authors state no conflict of interest.

Data Availability ***(mandatory)***

The data that support the findings of this study are available from the corresponding author, [initials, DDP], upon reasonable request.

Biographies of Authors

Dhito Dwi Pramardika works at Nusa Utara State Polytechnic as a lecturer and researcher. He was born in Manokwari on October 17, 1987. He obtained a Bachelor's degree in Public Health from Mulawarman University and then continued his Master's studies at Respati Indonesia University in the field of Public Health. His doctoral degree was obtained from IPB Univeristy, with a focus on Parasitology and Medical Entomology. His unique identity in Scopus is 59419507500. His research covers various topics in the field of environmental health, with special expertise in parasitology and health entomology. Dhito Dwi Pramardika is open to academic communication and collaboration, and can be contacted via email at dhitodwi@gmail.com.

Meityn Disye Kasaluhe works at Nusa Utara State Polytechnic as a lecturer and researcher. She was born in Tahuna on February 17, 1992. She obtained a bachelor's degree in Public Health from Sam Ratulangi University and then continued his master's studies at Gadjah Mada University in the field of environmental health. Her research covers various topics in the field of environmental health. Meityn Disye Kasaluhe is open to academic communication and collaboration and can be contacted via email at m.kasaluhe@gmail.com.

Mareike Doherty Patras works at Nusa Utara State Polytechnic as a lecturer and researcher. she was born in Tahuna on march 9, 1968. She earned hers bachelor's degree from Universitas Kristen Indonesia Tomohon (UKIT) in the faculty of health and behavioral sciences, and then pursued a master's degree at Universitas Sam Ratulagi Manado, Indonesia. She had conducted various health studies. Mareike Doherty Patras is open to academic communication and collaboration and can be contacted via email at mareikepatras68@gmail.com

Nansy Delia Pangandaheng works as a lecturer at the Nusa Utara State Polytechnic. She was born in Manado on November 29, 1987. She obtained her bachelor's and professional degrees in nursing from Sam Ratulangi University and continued her master's studies at Airlangga University in the field of Nursing. Her research covers various topics in the field of mental health nursing. Nansy Delia Pangandaheng is open to academic communication and collaboration and can be contacted via email at nansydeliapangandaheng@gmail.com.

Grace Angel Wuaten works at Nusa Utara State Polytechnic as a lecturer and researcher. She was born in Tahuna on September 23, 1990. She obtained a bachelor's degree in Public Health from Sam Ratulangi University and continued his master's studies at Gadjah Mada University in the field of epidemiology. Her research covers various topics in the field of epidemiology. Grace Angel Wuaten is open to academic communication and collaboration and can be contacted via email at gracewuaten@gmail.com.

Agneta Sartika Lalombo works at the Nusa Utara State Polytechnic as a lecturer. She was born in Tahuna on August 22, 1989. She earned her bachelor's degree in English literature from Sam Ratulangi University and continued her master's studies in linguistics/applied linguistics at Sam Ratulangi University. Her research covers various topics in education. Agneta Sartika Lalombo is open to academic communication and collaboration and can be contacted via email at lalomboagneta@gmail.com.

References

[1] R. M. Katak, A. M. Cintra, B. C. Burini, O. Marinotti, J. A. Souza-Neto, and E. M. Rocha, "Biotechnological potential of microorganisms for mosquito population control and reduction in vector competence", Insects, vol. 14, no. 9, pp. 1–25, August 2023, doi: 10.3390/insects14090718.

[2] A. Minwuyelet A, G. P. Petronio, D. Yewhalaw, A. Sciarretta, I. Magnifico, D. Nicolosi, R. D. Marco, and G. Atenafu, "Symbiotic wolbachia in mosquitoes and its role in reducing the transmission of mosquito-borne diseases: updates and prospects", Front Microbiol, vol. 14, pp. 1–12, Oct 2023, doi: 10.3389/fmicb.2023.1267832.

[3] W. Gu, J. L. Regens, J. C. Beier, and R. J. Novak, "Source reduction of mosquito larval habitats has unexpected consequences on malaria transmission", Proceedings of the National Academy of Sciences of the United States of America, vol. 103, no. 46, pp. 17560–17563, Nov 2006. doi: 10.1073/pnas.0608452103.

[4] P. Okeke, J. Luka, and G. I. Yina, "An overview of insecticide usage and resistance of insect vector to insecticide: an implication to public health", J Public Heal Dis, vol. 5, no. 2, pp. 16–20, Apr 2022, doi: 10.31248/JPHD2021.109.

[5] M. Mohammed, N. Shafiq, A. Elmansoury, A. B. A. Al-Mekhlafi, E. F. Rached, N. A. Zawawi, A. Haruna, A. D. Rafindadi, and M. B. Ibrahim, "Modeling of 3r (reduce, reuse and recycle) for sustainable construction waste reduction: a partial least squares structural equation modeling (pls-sem)", Sustain, vol. 13, no. 19, pp. 1–22, Sept 2021, doi: 10.3390/su131910660.

[6] A. Ioannidis, K. J. Chalvatzis, L. C. Leonidou, and Z. Feng, "Applying the reduce, reuse, and recycle principle in the hospitality sector: its antecedents and performance implications", Bus Strateg Environ, vol. 30, no. 7, pp. 3394–4100, Apr 2021, doi: 10.1002/bse.2809.

[7] M. R. Pinto, P. M. D. S. Parreira, M. L. Basto, and L. S. M. Mónico, "Impact of a structured multicomponent educational intervention program on metabolic control of patients with type 2 diabetes", BMC Endocr Disord, vol. 17, no. 1, pp. 1–10, Des 2017, doi: 10.1186/s12902-017-0222-2.

[8] S. Pratiwi, E, Rosa, P. Priyambodo, and T. Tugiyono, "Population of aedes sp. mosquito eggs in ovitraps treated with sugar fermentation as a natural attractant in the FMIPA University of Lampung campus environment", J Biol Papua, vol. 12, no. 2, pp. 109–113, Okt 2020, doi: 10.31957/jbp.1117.

[9] M. F. Cooperband, and R. T. Carde, "Comparison

of plume structures of carbon dioxide emitted from different mosquito traps", Med Vet Entomol, vol. 20, no. 1, pp. 1–10, Mar 2006, doi: 10.1111/j.1365-2915.2006.00614.x.

[10] M. Genc, "The project-based learning approach in environmental education", Int Res Geogr Environ Educ, vol. 24, no. 2, pp. 105–17, Feb 2015, doi: 10.1080/10382046.2014.993169.

[11] F. La Barbera, and I. Ajzen, "Control interactions in the theory of planned behavior: rethinking the role of subjective norm", Eur J Psychol, vol 16, no. 3, pp. 401–417, August 2020, doi: 10.5964/ejop.v16i3.2056.

[12] Y. Huang , K. M. Kendrick, R. Yu, "Conformity to the opinions of other people lasts for no more than 3 days", Psychol Sci, vol. 25, no. 7, pp: 1388–1393, July 2014, doi: 10.1177/0956797614532104.

[13] W. Collins, and L. Redden, "Improving student's estimating abilities through experiential learning", Int J Constr Educ Res, vol. 17, no. 2, pp. 117–132, Mar 2021, doi: 10.1080/15578771.2020.1739178.

[14] S. Lee, and L. R. Manfredi, "Promoting recycling, reducing and reusing in the school of design: a step toward improving sustainability literacy", Int J Sustain High Educ, vol. 22, no. 5, pp. 1038–1054, Apr 2021, doi: 10.1108/IJSHE-11-2020-0443.

[15] M. A. Alafnan, "Enhancing educational outcomes using alafnan taxonomy: integrating cognitive, affective, and psychomotor domains", Int J Eval Res Educ, vol. 14, no. 3, pp. 2419–2437, Feb 2025, doi: 10.11591/ijere.v14i3.33147.

[16] A. Hetling, and H. Botein, "Positive and negative effects of external influences on program design", Nonprofit Manag Leadersh, vol. 21, no. 1, pp. 177–194, Dec 2010, doi: 10.1002/NML.20019.

[17] G. G. Peterson, J. Zurovac, R. S. Brown, K. D. Coburn, P. A. Markovich, S. A. Marcantonio, W. D. Clark, A. Mutti, and A. Stepanczuk, "Testing the replicability of a successful care management program: results from a randomized trial and likely explanations for why impacts did not replicate", Health Serv Res, vol. 51, no. 6, pp. 2115–2139, Oct 2016, doi: 10.1111/1475-6773.12595.

[18] A. Isari, A. F. Hidayat, and U. Jambi, "The role of teachers as facilitators in enhancing primary school children's creativity", TSAQOFAH, vol. 5, no. 4, pp. 3817–3827, July 2025, doi: 10.58258/jisip.v8i3.7143.

[19] P. Ponte, "How teachers become action researchers and how teacher educators become their facilitators", Educ Action Res, vol. 10, no. 3, pp. 399–422, Feb 2002, doi: 10.1080/09650790200200193.

[20] P. Tavitiyaman, X. Zhang, and H. M. Chan,"Impact of environmental awareness and knowledge on purchase intention of an eco-friendly hotel: mediating role of habits and attitudes", J Hosp Tour Insights, vol. 7, no. 5, pp. 3148–3166, July 2024, doi: 10.1108/JHTI-08-2023-0580.