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Education on the effectiveness of sugar-based mosquito traps in controlling dengue fever vectors

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ABSTRACT

Dengue hemorrhagic fever (DHF) is a serious health problem in Indonesia with the Aedes aegypti mosquito as the main vector. This study aims to evaluate the effectiveness of sugar solution-based mosquito traps in reducing mosquito populations at SD Ummu Aiman. The traps were made using simple materials and then distributed to the school's mosquito-prone areas. Socialization and education were conducted for teachers through presentations, questions and answers, and hands-on practice of making the traps. Their effectiveness was evaluated through an online questionnaire. The results showed a significant reduction in the frequency of mosquito presence after trap installation, with an increase in respondents who no longer encountered mosquitoes from 5 percent to 25 percent. 85 percent of respondents considered the traps effective and safe, and the majority were willing to implement them in their area. The program successfully increased teachers' knowledge and engagement in mosquito control, despite facing constraints such as limited time, resources, and odor from the traps. Continuous support and regular evaluation are expected to increase the effectiveness and acceptance of this innovation. The sugar solution-based mosquito trap innovation is expected to be an environmentally friendly and sustainable solution for dengue vector control in schools.

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1. INTRODUCTION

The prevalence of Dengue Fever (DBD) in Indonesia shows a significant number of cases each year, making it one of the serious public health issues. This disease, caused by Dengue virus infection, is transmitted through the bite of the Aedes aegypti mosquito, which thrives in tropical and subtropical regions like Indonesia (Mahardika et al., 2023). Climate factors, population density, and environmental conditions that support mosquito breeding often lead to an increase in DBD cases during the rainy season.

According to the Regulation of the Minister of Health of the Republic of Indonesia No. 374/ MENKES/PER/III/2010 concerning vector control, all activities or actions aimed at reducing vector populations to the lowest possible level are intended to ensure that their presence no longer poses a

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risk for disease transmission in an area or to prevent public contact with vectors so that vector-borne diseases can be avoided. The control of Aedes aegypti mosquitoes has been carried out using various methods, such as physical and mechanical control through Mosquito Nest Eradication (PSN). This effort is a community-based empowerment program better known as PSN 3M Plus, which includes: draining (cleaning/draining water reservoirs such as bathtubs, water drums/tanks, clay jars, etc.), sealing (sealing water storage containers tightly), and recycling (repurposing discarded waste items) (Safira et al., 2022).

Additionally, biotic agents are used, such as predators that consume mosquito larvae (e.g., betta fish, rice field fish, etc.), bacteria, viruses, fungi, and genetic manipulation (e.g., the use of sterile male mosquitoes). Chemical control methods include surface spraying (IRS), space spraying (thermal fogging and cold ULV fogging), and household insecticides such as repellents, mosquito coils, aerosols, etc. (Nurbaya et al., 2022).

The most commonly known and implemented method of controlling the spread of DBD vector mosquitoes by the public is the conventional PSN 3M Plus method. Additionally, if a DBD patient is detected in an area, the next step is fogging. The fogging method involves spraying insecticides in targeted areas to eliminate adult mosquitoes, particularly in high-risk zones for disease transmission. This spraying is typically conducted by health workers as an effort to break the transmission chain of mosquito-borne diseases. Another commonly used method is the use of egg traps (ovitraps) and adult mosquito traps (mosquiTraps). Ovitraps work by providing a trapping container that attracts mosquitoes to lay eggs inside and capturing adult mosquitoes. By using ovitraps, mosquito populations in surrounding environments can be effectively controlled, especially during the rainy season when mosquito breeding increases (Sazali et al., 2024; Lau et al., 2015).

As a response to the limitations of conventional methods in controlling Aedes aegypti mosquitoes (Saleh et al., 2021; Mariana et al., 2022), an innovation in vector control based on sugar solution has emerged. This innovation involves using mosquito traps containing a solution of warm water, brown sugar, liquid soap, and yeast, mixed evenly. This solution has effective physical and chemical attractants for mosquitoes and is placed in dark-colored containers since mosquitoes are more attracted to such colors (Sazali et al., 2024). The container is then placed inside a square acrylic box measuring 30 x 30 cm, lined with black stickers, and distributed in areas with high mosquito populations. This trap is considered effective in reducing mosquito populations without causing negative environmental impacts or health risks to the surrounding community, making it an innovative, eco-friendly, and safe long-term alternative.

Education is estimated to be a major factor influencing the understanding of diseases and their transmission, as well as attitudes and practices, particularly in involving school communities in dengue control efforts (Hendri et al., 2020). SD Ummu Aiman in Lawang District, Malang, has played a role in preventing the spread of this disease, including the active involvement of teachers in educating students. Additionally, teachers participate in community service activities focused on DBD prevention by practicing the sugar-water-based mosquito trap innovation. This initiative aims to raise awareness and understanding among both students and the school environment. The involvement of students at all educational levels, along with teacher support, is necessary to anticipate disease transmission in educational settings.

This community service activity was carried out at an elementary school in Malang Regency, SD Ummu Aiman. SD Ummu Aiman is located at Jalan Argopuro No. 20, Lawang District, Malang Regency. Established in 1999, it is a pioneer Islamic school in Lawang District. With a land area of 3,379 m^2, the school has 22 classrooms, a computer lab, a science lab, a canteen, a prayer room, a school health unit (UKS), and a library (Irham & Sasongko, 2023). SD Ummu Aiman has maintained an A accreditation rating during the periods of 2013, 2016, and 2019.

The main motivation for conducting this community service at SD Ummu Aiman is to address the high risk of Dengue Hemorrhagic Fever (DHF) transmission caused by school density and limitations in managing the environment, which serves as a breeding ground for Aedes aegypti mosquitoes. With DHF cases reported at the school in 2023, this program aims to educate the school community about mosquito vector knowledge and implement vector control strategies through the innovation of sugar-water-based mosquito traps. This initiative is expected to effectively reduce mosquito populations in an environmentally friendly and sustainable manner.

The SD Ummu Aiman community generally recognizes DHF prevention methods based on socialization activities conducted by the Ministry of Education or the Ministry of Health. A low level of knowledge affects the implementation of DHF prevention efforts. The higher the knowledge of the SD community regarding DHF vector control, the greater their motivation to engage in prevention and control measures (Salam, 2020). The reception of information by the school community varies depending on how well it is conveyed within the school or through government education and health initiatives.

Based on research findings, the following are general insights known to the SD community: Children understand that Aedes aegypti mosquitoes are the vector of DHF. They have been informed that controlling the disease vector is crucial to preventing its spread. They are also aware that the mosquito breeds in stagnant, dark water. Furthermore, they recognize common vector control methods such as the 3M approach. Additionally, maintaining environmental cleanliness by eliminating standing water, avoiding waste buildup, and reducing excessive hanging clothes is believed to help lower mosquito populations, particularly DHF vectors (Hendri et al., 2020; Kusumawati, 2016).

Understanding the control and prevention of DHF vectors must involve cooperation across all age groups, especially since SD schools primarily consist of children aged 6–12 years. Therefore, it is crucial to present this information in ways that can be easily understood by all, such as through pictures, stories, or interactive activities. Children can also practice prevention measures at school, such as cleaning the surrounding areas, which reinforces these concepts in their minds. Continuous education and parental involvement are key to ensuring a strong understanding of DHF vector control (Hendri et al., 2020; Kusumawati, 2016).

The objective of this study is to determine the effectiveness of sugar-water-based mosquito traps in reducing mosquito populations in the school environment. Additionally, the study aims to assess teachers' perceptions of the mosquito trap implementation and provide useful recommendations for improving the use of mosquito traps in schools so that their application can be sustained and further developed. An illustration of the activities that address these objectives is presented in Figure 1.

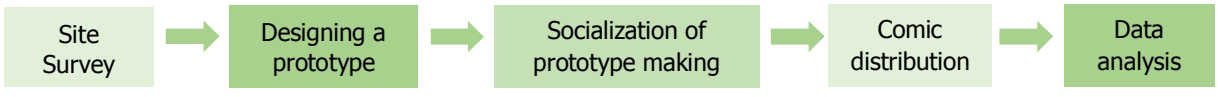

Figure 1. Problem solving solution framework

2. METHODS

Research Location

The research was conducted to solve the problems found in Ummu Aiman Elementary School, Lawang District where sugar-based mosquito traps will be installed. Preparation of tools and materials was carried out at the Environmental Laboratory, Department of Civil Engineering and Planning, State University of Malang. This research was conducted in the period May-September 2024.

Figure 2. Location of Ummu Aiman Elementary School, Lawang District

Prototype Design

This sugar-based mosquito trap is an alternative solution that can be made using simple tools and materials readily available at home. The trap requires tools and materials such as an acrylic box (or a used cardboard box as a substitute), a black bucket, warm water, brown sugar, yeast, and liquid soap. It is highly recommended that the bucket be black, as mosquitoes are more commonly found in dark places (Gama & Pratiwi, 2017).

The first step in making this trap is dissolving approximately 500 ml of warm water with one sachet of yeast, then adding two tablespoons of brown sugar and stirring until fully dissolved. After that, one tablespoon of liquid soap is added to the mixture. Next, the bucket containing the solution is placed inside the acrylic box or used cardboard box. The final step is distributing the traps in mosquito-prone areas, with monitoring every three days to evaluate their effectiveness.

The analysis and evaluation phase includes assessing the number of mosquitoes caught and adjusting the trap's placement to ensure even mosquito distribution across the school environment, thereby maximizing its effectiveness. The prototype can be seen in Figure 3.

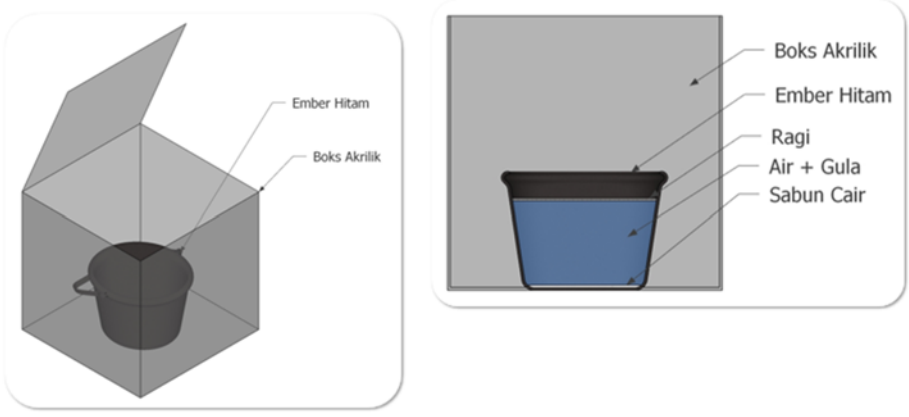

Figure 3. Prototype image of sugar-based mosquito trap

Socialization and Education

The socialization activity was conducted to explain and demonstrate how to create a sugar-based mosquito trap so that participants could apply this knowledge elsewhere, particularly in their own homes. Additionally, it aimed to pass on this practice to the students of SD Ummu Aiman as part of the implementation of vector control and DBD prevention.

The socialization method involved a presentation using PowerPoint, a Q&A session, and a hands-on mosquito trap-making workshop guided by the researchers. This activity was conducted indoors using PowerPoint and interactive discussions, which facilitated focused information transfer and engagement without external distractions. The Q&A method helped students sharpen their memory, enhance critical thinking, and improve concentration (Asriadi & Masni, 2021; Laia, 2022).

Following the presentation, participants practiced making the sugar-based mosquito traps under the researchers' guidance. They then distributed the traps in locations where they believed mosquitoes and other insects were most prevalent.

Data Collection

Data collection was conducted using a questionnaire approach for participants of the socialization program that had taken place one month earlier. This method has also been used in several studies to gather participant responses regarding socialization activities (Setiawan & Syaifuddin, 2020). The questionnaire was distributed online via Google Forms to assess participants' perceptions of the effectiveness of sugar-based mosquito traps in the school area. It included questions about their opinions on the trap's effectiveness, ease of use, and their willingness to implement it in their own living environments. Additionally, the questionnaire collected suggestions and expectations from participants to improve the method in the future.

Data Analysis

The collected data was analyzed descriptively to assess participants' perceptions regarding the frequency of mosquito population changes and their responses about the effectiveness, safety, and willingness to use the trap in their living environment. Additionally, thematic analysis was conducted to categorize respondents' suggestions. This categorization provided in-depth insights into various aspects that needed improvement or were positively received by users.

3. RESULTS AND DISCUSSION

Results

The implementation phase of this community service project was divided into two stages: the socialization and education stage, and the data collection stage. A one-month gap was given between these stages to allow participants to observe any changes that occurred. After completing these two stages, the data analysis phase was conducted.

The socialization and education stage was carried out using PowerPoint presentations in an indoor setting. This session covered background information, including an overview of DBD, transmission factors, and control measures. Additionally, data on the increasing number of DBD cases in Malang Regency, including Lawang District, was presented.

The session also introduced the latest innovation: the sugar-based mosquito trap, explaining its design, working mechanism, and step-by-step production process. The required materials included yeast (1 sachet), brown sugar (2 tablespoons), liquid soap (1 tablespoon), warm water (±500 mL), and

tissue. The necessary tools included a black bucket, a box (either cardboard or acrylic), and a spoon. It was strongly recommended to use dark or black-colored buckets and boxes, as mosquitoes tend to seek shelter in dark places.

For the box, participants could use leftover cardboard or opt for acrylic boxes to ensure durability against larger animals or human interference. This was important since the traps were placed in a school setting with frequent outdoor activities and high foot traffic. Additionally, using a more durable container helped prevent damage from spills or rain, as some traps were placed outdoors.

The mosquito trap-making session involved dividing participants into 10 groups, with each group creating traps under the guidance of the researchers. Each group was accompanied by a student assistant responsible for documenting the activity. The socialization session took place at the research location, as shown in Figure 4.

Figure 4. Socialization and education activities for making mosquito traps based on sugar water

The next implementation stage was the data collection phase, which was conducted using a questionnaire as the instrument. The goal was to gather participants' responses regarding the sugar-based mosquito trap program. Although the questionnaire was distributed to all participants, only 20 participants responded. These 20 participants represented each group from the socialization activity. The questionnaire consisted of three sections. The first section assessed changes in mosquito frequency before and after using the mosquito trap. The second section evaluated the effectiveness of the trap and participants' willingness to implement it. The third section collected suggestions and expectations for future improvements. The questionnaire results can be seen in Figure 5.

Figure 5 presents the results of the first section of the questionnaire, which assessed mosquito frequency before and after installing the mosquito traps.

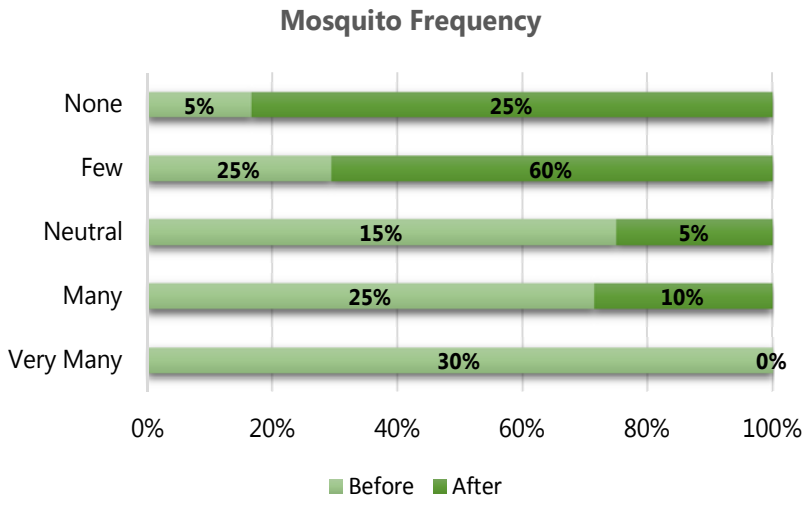

Figure 5. Frequency of mosquitoes before and after installing a sugar water-based mosquito trap

The data indicates a significant reduction in mosquito encounters after the traps were installed. In the "None" category, the percentage increased from 5 percent before installation to 25 percent after installation, showing that more respondents reported no longer encountering mosquitoes. The "Few" category also increased from 25 percent to 60 percent, signifying a substantial reduction in the mosquito population. Meanwhile, the "Neutral" category decreased from 15 percent to 5 percent, the "Many" category dropped from 25 percent to 10 percent, and the "Very Many" category fell from 30 percent to 0 percent, meaning no respondents reported a very high mosquito frequency after installing the traps.

Overall, this data suggests that sugar-based mosquito traps effectively reduce mosquito presence in the school environment. The decrease in high-frequency categories and the increase in low-frequency categories demonstrate the trap's positive impact in lowering the mosquito population. These findings provide strong support for implementing this method on a larger scale in mosquito control programs, particularly in areas prone to dengue fever outbreaks.

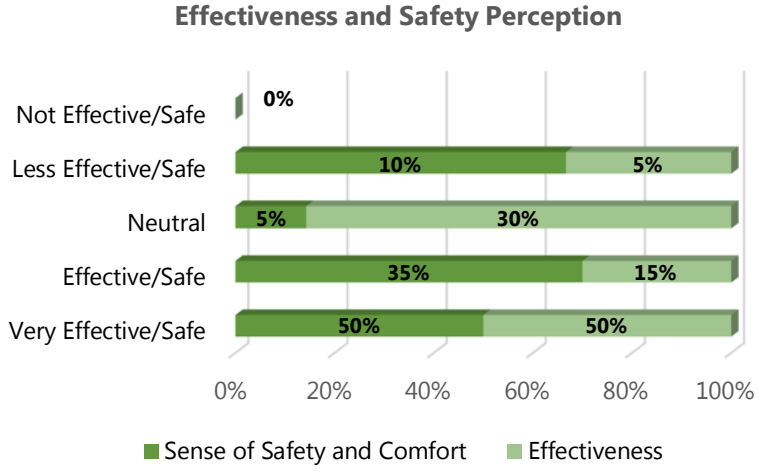

Figure 6. Feeling of safety and effectiveness after installing mosquito traps

The second section of the questionnaire focused on respondents' willingness to apply the mosquito traps in their home environments. Out of 20 respondents, 10 were "very willing," 7 were "willing," 1 was neutral, 2 were "less willing," and none were "unwilling." This indicates that most respondents accepted the mosquito trap as an innovation for dengue vector control.

The 18 respondents who accepted the trap as a viable solution for their home environments were then asked about their sense of safety and comfort after installation, as well as their perception of the trap's effectiveness. A more detailed breakdown of these results is shown in Figure 6.

The survey results on respondents' perceptions of the effectiveness and safety of sugar-based mosquito traps are displayed in Figure 6. The diagram categorizes responses into five groups: "Not Effective," "Less Effective," "Neutral," "Effective," and "Very Effective."

According to the survey, 50 percent of respondents considered the trap very effective and safe, indicating high confidence in this mosquito control method. Additionally, 35 percent of respondents found the trap effective and safe, while 15 percent rated it as effective.

In the "Neutral" category, 5 percent of respondents felt safe and comfortable using the trap, while 30 percent rated its effectiveness as neutral. For the "Less Safe" category, 10 percent of respondents felt moderately safe using the trap, and 5 percent considered its effectiveness low. Notably, no respondents rated the trap as "Not Safe," suggesting a generally positive acceptance of its safety and effectiveness.

Overall, this data indicates that the sugar-based mosquito trap is perceived as both effective and safe by most respondents, with a strong concentration of positive responses in the "Very Safe" category. This highlights the trap's potential as a scalable vector control solution, particularly in areas with a high risk of dengue transmission. These findings provide a strong scientific foundation for developing innovative and sustainable mosquito control programs in community settings.

Discussion

The community service program in the form of socialization and education on making sugar-based mosquito traps is relevant to the school's needs for mosquito control. This initiative serves as an implementation of dengue prevention programs, where Aedes aegypti mosquitoes act as disease vectors. The training aims to enhance participants' knowledge of mosquito trap construction, which is expected to be applicable in various settings. Additionally, this technology is accessible to all groups, from students to teachers at SD Ummu Aiman. However, teaching it directly to students requires considerable time due to the large number of participants. Therefore, this program was attended by selected teachers who are expected to later disseminate the knowledge to their students and communities.

The socialization activity proceeded with a presentation followed by trap construction and distribution to locations chosen by participants. The introductory material covered the demographics of Malang Regency and Lawang District, an overview of Aedes aegypti mosquitoes as dengue vectors, and the importance of environmental cleanliness in controlling mosquito populations (Sazali et al., 2024). Participants then built the mosquito traps under the researchers' guidance and placed them in areas they frequently encountered mosquitoes. The entire process, from construction to distribution, was efficient. Following this, participants were introduced to the method of counting trapped mosquitoes, which should be checked every 3–4 days. However, based on interviews, participants did not count the captured mosquitoes but instead discarded and replaced the trap liquid directly.

Based on questionnaire data collected via Google Forms, the community service program conducted by researchers from Universitas Negeri Malang produced the following results: (1) The program positively impacted the frequency of mosquito encounters before and after trap distribution. As

shown in Figure 5, the number of mosquito encounters significantly decreased; (2) A total of 95 percent of participants found the traps effective for dengue vector control, while 90 percent reported feeling safe and comfortable with their presence (Figure 6). The sense of security arose from the trap's proven effectiveness in reducing mosquito populations; (3) The high level of awareness among participants, who generally have strong educational backgrounds, contributed to their understanding of Aedes aegypti mosquitoes as dengue vectors and their commitment to mosquito control efforts (Espiana et al., 2022).

This community service program was successfully implemented due to several supporting factors: (1) Facilities and Equipment – The school provided an auditorium and supporting equipment such as projectors and a sound system for the socialization and education activities; (2) Active Participation of Teachers – Teachers actively engaged in the socialization program and showed willingness to apply the technology in their homes and classrooms. Their enthusiasm was evident in their participation in discussions, question-and-answer sessions, and sustained engagement throughout the event; (3) Administrative Support – The school administration was highly cooperative, promptly assisting with necessary administrative requirements to ensure the smooth execution of the program; (4) Further Collaboration – SD Ummu Aiman expressed interest in conducting follow-up training for students. In the final discussion, the school suggested continuing the program, reflecting its success and positive reception.

The program's effectiveness was evident in the participants' enthusiasm during the presentation and their active involvement in making the traps. Some participants documented the process to implement it at home or use it as additional teaching material in class (Astuti & Purwoko, 2017). These activities are illustrated in Figure 4.

Despite its success, the program faced several challenges during implementation: (1) Limited Time – Aligning with the school's packed academic and non-academic schedule made it difficult to arrange additional socialization sessions. Researchers also needed more time for follow-up programs or full-scale student socialization, but scheduling conflicts prevented this; (2) Limited Resources – The researchers prepared only 10 mosquito traps with materials accordingly. However, participants faced difficulties maintaining the traps as they either forgot or did not prepare replacement liquids, disrupting the maintenance process; (3) Unpleasant Odor – Some participants noticed an unpleasant smell from the traps due to the liquid mixture, which discouraged proper maintenance and further hindered the program's effectiveness.

4. CONCLUSION AND RECOMMENDATIONS

This community service program aims to provide knowledge and experience to participants in making mosquito traps at Ummu Aiman Elementary School, Lawang District. This activity is an effort to control the transmission of dengue fever through Aedes Aegypti as a vector of dengue fever. The target to be achieved in this activity is that participants are able to implement the results of mosquito trap products in their residential environment and to students in classroom learning activities. The implementation of this program is carried out in 2 stages, namely the socialization and education stage, and the data collection stage. The main factors for the success of this activity lie in the facilities of the place and means, active participation of teachers, administrative support and further collaboration obtained from Ummu Aiman Elementary School, Lawang District. The results achieved from this community service activity are the ability of participants in making mosquito traps and their willingness to apply them in their surroundings and in classroom learning activities. However, several things that hinder this community service activity include: limited time, limited resources, and discomfort with the smell produced by the mosquito trap. Most of the participants expressed their willingness to implement

this tool in their residential environment, so it is hoped that with this activity teachers can properly implement it in their environment, especially in classroom learning activities.

There needs to be monitoring and evaluation conducted by the school as a form of sustainability for the program implemented by the researcher. This follow-up is necessary to ensure that no equipment is damaged due to the short maintenance process, which involves changing the liquid every 3-4 days alongside harvesting the trapped results. Given the participants' complaints about the unpleasant odor produced by the device, a reassessment is needed to add a fragrance that can eliminate the bad smell for greater comfort. Additionally, the container used can be adjusted based on the available buckets or replaced with a box that fits the trap's placement location to save space. The number of traps distributed can also be increased according to the school's area size. Regular mentoring and monitoring should be conducted to achieve sustainable results. Ideally, this technology can be applied to the wider community through PKK, social gatherings, or other community meetings.

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