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Development of STEM-based Water Filtration to Improve Water Quality in Pontang

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Abstract

This study aimed to improve water quality in Pontang, Serang Regency, through the development of STEM (Science, Technology, Engineering, and Mathematics)-based water filtration. The method used a case study by conducting an observation of water conditions, designing and testing filters using local materials (cassava peel charcoal, zeolite, beach sand, white silica sand), as well as socialization and training for the community. The activities were carried out over six months (May to July 2025) involving the Family Welfare Empowerment (PKK) and *Karang Taruna* of Pontang. The results show that STEM-based water filters can improve water clarity, reduce odor, and are well received by the community. User response evaluations show a high level of satisfaction, especially regarding the ease of use and effectiveness of the tools. In conclusion, this innovation has the potential to be an applicable and sustainable solution for providing clean water.

Keywords: Water Filtration; STEM, appropriate technology, Pontang

INTRODUCTION

Potable water, which is a human basic right, is still difficult to obtain in some of the coastal villagers in Indonesia. One village, Pontang Village in Serang Regency, is in a critical state as it has brackish groundwater while its surface water supply is polluted with domestic waste. This situation is detrimental to public health due to the high risk of skin diseases, diarrhea, and respiratory problems (Widiastutie, 2024). Provision of clean water to the countryside remains in general underdeveloped. PAM government program also do not reach all areas (Oktafiani & Nugraheni, 2024) thus community is relying on low quality rivers. Hence, suitable technology should be economically and eco-friendly, and applicable to an extent by the community. Prior research has demonstrated the efficiency of natural materials in the filtration process, including silica sand, zeolite, and charcoal (Amna et al., 2019; Sutikno et al., 2022). At the village community level, however, its use is still quite limited. This water filter innovation uses the STEM approach to improve community knowledge and skills in addition to solving technical issues.

The main objectives of this study are:

1) To develop a simple STEM-based water filtration using local materials.
2) To empower the Pontang community through training and socialization on the use of the filter.
3) To evaluate the community's response to the effectiveness and usefulness of the filter.

METHOD

The program was used a case study in Pontang, Serang Regency, from June to December 2025. The implementation methods consisted of:

1. Initial Observation: Mapping environmental conditions and water quality, along with community and official interviews, comprised the implementation approaches.
2. STEM-based Filter Development: Zeolite, beach sand, white silica sand, and activated carbon from cassava bark charcoal were used in the construction of acrylic filters. Every substance has a distinct role in lowering turbidity, holding onto solid particles, and absorbing contaminants.
3. Socialization and Training: The PKK women's group and the Karang Taruna youth organization participated in the activities. Participant hands-on practice, filter assembly demonstrations, and instruction on the value of clean water were all part of socialization.
4. Evaluation: Evaluation was conducted through pre-tests and post-tests, user response questionnaires (Likert scale 1–5), and open discussions with the community.

RESULTS AND DISCUSSION

The creation of a STEM-based water filter was the next step in carrying out this community service project after the required equipment and supplies were made available. The best material composition to create a water filter with the best filtration capacities was then determined through methodical testing. The full set of events took place between May and July of 2025.

1. Filter Development: Acrylic with distinct material arrangements was used in the STEM-based filter's final design. The water clarity significantly improved, according to the test results. While silica sand decreased turbidity, carbon from cassava peels efficiently absorbed contaminants and smells.
2. Socialization and Training: Fifty people (students, Karang Taruna, Family Welfare Empowerment (PKK), and local officials) attended socialization in August 2025. Participants actively participated in the filter-making process with a great deal of excitement.
3. User Reaction: Over 90% of respondents said the filter was very useful, easy to use, and suggested, according to the survey results. Two things that should be improved are the long filtration time and the relatively small filter capacity.
4. Discussion: These findings are in line with studies by Amna et al. (2019) and Amiruddin & Wibowo (2024), which demonstrate the effectiveness of regional materials as filtration media. The program's biggest feature is its participatory approach, which enables the community to be both producers and users.

Figure 1. Provision of tools and materials and testing of water filter development.

Figure 1 shows the search for various tools and materials suitable for water filter construction, such as stacking used bottles at specific thicknesses, arranging the materials in each layer, and then testing. This series of tests revealed the most effective STEM-based water filter design: an acrylic filter with a unique combination of filter materials. he test results demonstrated that the STEM integration resulted in clearer water. Four types of materials were used: carbon, zeolite, beach sand, and white silica sand. White silica sand reduces water turbidity caused by suspended solids (Nur et al., 2020), porous zeolite acts as an adsorbent to absorb pollutants (Amna et al., 2019), and beach sand acts as a physical barrier to trap solid particles (Eichmanns et al., 2021). Carbon from cassava peel eliminates odors and colors and improves water clarity by absorbing contaminants like chlorine, heavy metals, and organic substances (Amna et al., 2019).

Before cassava peel is used for water filtration, cassava peel is sun-dried for seven days first, then baked to activate its carbon content. In order to ensure that the final product is ideal for socialization and community display, this trial phase takes a significant amount of time because it entails choosing the design, preparing the materials, and obtaining the tools. Accordingly, a survey was carried out in June 2025, along with conversations and correspondence with officials to develop collaboration over the execution of the community service program. In addition to gathering pertinent field data, the survey and communication efforts sought to better understand community needs so that the program would be focused, sustainable, and offer observable advantages for enhancing the local community's welfare and environmental quality.

The major program, which took place over two days in August 2025, came after this community service project. A socializing session about the value of clean water for everyday life was the first activity in this community service initiative. On Wednesday, August 13, 2025, the event took place at the Official's House on Jl. Banten Lama, Pontang, Serang Regency, Banten. A biology education lecturer from a public university in Banten, Indonesia, gave a

presentation as part of this socialization exercise. The entire community was requested to complete a pre-test on general clean water knowledge before to the presentation, which was undoubtedly pertinent to the content that will be covered. The socialization materials explained the importance of water in daily life, the qualities of clean water and the risks of contaminated water, and the consequences of using unfit water, including skin diseases, cholera, diarrhea, and other health problems. Participants were also introduced to a variety of clean water sources, including springs, bore wells, dug wells, and water company (PAM), all of which must be kept clean to prevent contamination from dirt or waste. Lecturers, students, PKK, youth groups (Karang Taruna), and the community all attended this socialization. The community's passion was reflected by their emphasis on the material and involvement in the Q&A session, making the engagement vibrant and supportive.

Participants in this community service project had hands-on experience making pre-made basic STEM-based water filters on the second day. The exercise was held at the same venue. During this session, the community was explained the function of each filter component and how to assemble it for effective use. In order to acquire both theoretical knowledge and useful skills that they could use in their everyday life, the participants which included PKK mothers, youth groups (Karang Taruna), students, and lecturers were actively involved in the assembly process.

The activity was carried out as a demonstration, and participants were split up into four groups. Each group used a variety of filtering techniques, including 1,500 ml mineral water bottles, STEM-based water filters, and small beverage bottles stacked on top of each other. Examining each filter's ability to generate clean water and providing real-world examples of how simple water filters work were the goals of this variation. The participants' eagerness to put the filtration devices together and test them showed how well the exercise went.. The response from the community was overwhelmingly positive. Community representatives' impressions and communications indicated that this program was beneficial, suitable, and pertinent to their requirements about the supply of clean water.

The results of user response tests for water filters showed a high level of satisfaction. A total of 18 respondents filled out a Likert scale questionnaire (1–5). The average score for all aspects was in the range of 4.6–4.9 can be seen in Table 1.

Table 1. Summary of User Response Results

Evaluated Aspect	Average Score (1–5)	Description
Benefits of the device for daily life	4.9	Very beneficial
Savings on clean water costs	4.8	Agree – Strongly agree
Clarity & safety of filtered water	4.8	Very good

Evaluated Aspect	Average Score (1–5)	Description
Ease of use	4.7	Easy to use
Suitability of design & local materials	4.6	Relevant & applicable
Awareness of maintaining water quality	4.9	Very high

The public's reaction has been largely favorable. The majority of respondents claimed that the water filters are affordable, practical for everyday usage, and simple to operate. There have been recommendations, nevertheless, that the filtration process should be reduced and the filters' capacity should be enhanced.

CONCLUSION

The preparation of tools and materials, the creation of a STEM-based water filter design, and the testing of the filtration efficacy to obtain different filter combinations—from used mineral water bottles to acrylic materials with separate or stacked material arrangements that can produce clear water—all contributed to the successful completion of this community service project. Zeolite, beach sand, white silica sand, and carbon from cassava peel charcoal are combined in this filter to absorb contaminants, lower turbidity, and remove colors and odors from the water. In August 2025, the main activity—which included socialization and hands-on filter making—was conducted to give the community knowledge and practical skills so they could comprehend the value of clean water and practice creating basic filters. The enthusiasm of the participants showed how useful and relevant this program was to the needs of the community.

SUGGESTIONS

Further research and service to the community is needed, both first tested on a small scale and on a large scale by optimizing the use of water filter materials that come from the availability in the surrounding environment. In addition, a measuring instrument is needed to see the difference in the quality of filtered water, not only to see changes in clarity but also to salinity levels, pH, and others. The use of water filters on a wide scale seems to need to be modified so that the materials used in this study need to be re-tested

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