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Integrating bioscience into waste education management for sustainable development in the Philippines: The serve, understand, respect waste education management (SURWEM) extension project

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Abstract

The serve, understand, respect waste education management (SURWEM) extension project seeks to empower communities in sustainable waste management practices by integrating bioscience principles with local education efforts. In response to the growing challenges of solid waste generation and its environmental impacts, this initiative focuses on developing functional and sustainable backyard gardens within local barangays. The project promotes the use of organic fertilizers and pesticides, reinforcing the connection between waste management and ecological health. Over a span of three years, SURWEM uses a participatory approach to educate community members through research-based seminars, workshops, and hands-on training. Participants learn effective waste segregation techniques, recycling methods, and the application of bioscience in waste conversion processes. This comprehensive education framework aims to foster a culture of sustainability, encouraging local residents to engage actively in environmental stewardship. The project also emphasizes the importance of community partnerships and stakeholder involvement, ensuring that knowledge transfer is not only effective but also sustainable in the long term. By creating an inclusive platform for dialogue and sharing best practices, the SURWEM project generates a ripple effect in promoting waste management awareness across multiple barangays. Ultimately, this initiative contributes to the overarching goals of sustainable development by equipping individuals with the skills necessary to manage waste responsibly, enhance food security through community gardening, and pursue an eco-friendly lifestyle. Through these efforts, SURWEM strives to create resilient communities capable of addressing environmental challenges collectively.

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Introduction

Parallel to the rapid population and economic growth, urbanization, industrialization, and changing socioeconomic conditions is the unprecedented increase in solid waste generation.

Solid waste management (SWM) is a serious global issue as there is environmental public health, as well as aesthetic concerns associated with its safe disposal. Important concerns associated with solid wastes management includes the emission of large amount of greenhouse gases that have a significant influence on global warming, contamination of water and soil, production of unpleasant odor, and spread of diseases (Ishigaki *et al.*, 2011). Achieving significant reduction of solid waste necessitates waste diversion which in turn entails waste segregation at source. The latter is key to maximizing gains from waste diversion. Active participation of waste generators in waste diversion depends on proper waste segregation at source during which on-site re-use, recycling and composting are promoted. Waste segregation and collection are to be conducted at the barangay level specifically for biodegradable and recyclable wastes and eventually be recycled and others will be done at home through using compost if possible, while disposal and collection of nonrecyclable/residual and special wastes are the responsibility of the city or municipality. It was found out in the study "Effectiveness of the Implementation of the "No Segregation, No Collection Policy: The Case of Don Mariano Marcos Memorial State University (DMMMSU) Service Barangays (Philippines)" that in general, the policy is effective in terms of household awareness, reduction of collected household wastes; compliance of households in the community but three barangays in northern Philippines) failed to reduce household waste from May 2018 to June 2021. Thus, series of seminar-workshop/trainings/orientations was planned to conducted to the three service barangays of DMMMSU – NLUC (North La Union Campus), Philippines to address the said findings in the study "Effectiveness of the Implementation of the "No Segregation, No Collection Policy: The Case of DMMMSU Service Barangays (Philippines)" and to overall decrease generation of household solid wastes and increase awareness on solid waste management.

Based on the above-mentioned situation the compliance theory supported this extension program. Compliance theory states that organizations can be classified by the type of power they use to direct behavior of their members and the type of involvement of the participants. In conducting the SURWEM program, it is important to determine the proper means of communications to the household participants and protocol to be followed in its conceptualization. Hence, the extension workers are continuously conducting, implementing and monitoring the progress of the activities so as not to compromise to the objective of the study.

Meetings, orientation, training and seminar-workshop activities and other strategies were prepared to help the barangay officials of the service barangays to strictly implement waste management to the barangay folks.

Integrating bioscience into waste education management is vital for sustainable development. By utilizing principles from bioscience, the project fosters a deeper understanding of ecological interactions and the efficient recycling of organic waste. This integration empowers communities to use their waste sustainably, turning it into resources for composting and organic gardening.

Such practices not only mitigate waste but also contribute to enhanced soil fertility and biodiversity. The holistic approach provided by integrating bioscience encourages households to adopt a more sustainable lifestyle, bridging the gap between environmental education and actionable community practices. This project specifically focuses on promoting bioscientific techniques, thereby addressing increasingly complex environmental issues while simultaneously nurturing local ecosystems.

This project will help the barangay officials of the DMMMSU service barangays in the Philippines in strengthening their implementation of waste management (Fig. 1). This project will help them address the identified problems as a result of the research conducted. In addition, barangay folks will learn the different skills and strategies of turning waste into worthy things by attending the seminar-workshop which will be organized by the extension workers. Moreover, partnership with these service barangays will be done through MOA. DMMMSU-NLUC, Philippines will help and monitor this project until identified problems will be given proper remedy and practical solution. The extension workers (Science teachers, College of Education) started to share their knowledge about waste management since they are teaching Environmental Science, Earth Science, Ecology and other waste management related courses in the College of Education.

Scientific basis/theoretical framework

The Theory of Waste Management states that the traditional waste management view is centered on assurance compliance, risks management, health and environmental protection that are short term tactical (Esmaeilian *et al.*, 2018). This traditional perspective needs to evolve to incorporate integrative strategies that highlight the synergy between waste management and bioscience.

Integrating bioscience into waste education management is essential for promoting sustainable development; it equips community members with knowledge about microbial processes involved in waste decomposition, nutrient cycling, and the environmental impacts of waste practices. By understanding these bioscientific principles, individuals can better appreciate the ecological benefits of composting, recycling organic materials, and employing eco-friendly gardening techniques. This knowledge fosters a culture of stewardship, encouraging communities to adopt practices that reduce waste and enhance local biodiversity while optimizing waste resource recovery.

The same authors reshaped traditional waste management view into new value creation that can raise productivity, enhance relations, support eco-innovations, and enable growth for long term endeavors. But the focal point of practical waste management lies on three vital objectives; (1) waste quantification (2) waste characterization and (3) waste management methods or practices.

And the three waste management practices classification include: (1) prevention practices comprising strategies on waste minimization, (2) end-of-pipe strategies involves recovering the economic value on waste through waste separation, recycling, proper landfilling, incineration and (3) environmental restoration practices, aimed at repairing leakages and damages to the environment (Zaman, 2014). It was also correspondingly classified improving resident's awareness and legislation as preventive practices.

As a feedback to the growing problem of our country and different municipalities regarding Solid Waste Management, the Philippine government enacted Republic Act 9003 to serve as a groundwork in handling the problem to avoid any quandary in the future to the environment and to our health. Also, another goal of the aforesaid law is to develop plans for solid waste management to serve as a prototype and format which provinces, cities, and municipalities may use in meeting the requirements for National Solid Waste Management. Moreover, the law intents to perform environment-friendly methods such as reduce, re-use, recycle and composting to address the growing problem. Furthermore, it encourages local governments to impose sanctions to those who will violate environmental rules and regulations given by the government (RA 9003: Ecological Solid Waste Management Act of 2000).

To achieve the objectives of the abovementioned law and be implemented properly, the Department of Environment and Natural Resources (DENR) had set rules and guidelines through enacting DENR Administrative Order No. 34. The enacted Administrative Order emphasizes the strict

implementation of proper managing of wastes through following and utilizing best environmental practices in ecological waste management without the use of incineration. Also, solid waste avoidance and volume reduction can be achieved through reducing and minimizing the sources of wastes (DENR Administrative Order No. 34: Implementing Rules and Regulations of Republic Act 9003, 2001).

To strengthen and support the provisions stated in RA 9003 regarding imposing of sanctions to those who will violate environmental rules and regulations, residential Decree No. 825 was made and passed. It requires all citizens and residents of the Philippines to place their wastes in proper receptacles. Hence, anyone who will litter and throw their garbage anywhere can be imprisoned for not less than 5 days or more than a year and be fined not less than PhP 100.00 or more than PhP 2,000.00 or received both sanctions depending on the decision of the Court (Presidential Decree No. 825: Providing Penalty for Improper Disposal of Garbage and Other Forms of Uncleanliness and for Other Purposes, 1975). In addition to that, RA 7160 of the Local Government Code directed all LGUs are responsible and have the function to maintain the services and facilities for hygiene, sanitation, and especially for solid waste management. Thus, this shows that LGUs are obliged and have the responsibility to strictly carry-out the provisions stated in the RA 9003 within their area of responsibility (Republic Act 7160: An Act Providing for a Local Government Code of 1991, 1991).

Under the Administrative Order No. 90, a group composed of experts was created to help formulate an information and education plan to make people aware, understand, appreciate, and accept different forms of disposing of wastes (Administrative Order No. 90: Creating a Project Management Office on Solid Waste Management under the Presidential Task Force on Waste Management, 1993). In harmony with aforementioned legal frameworks, the Municipality of Bacnotan had passed the Municipal Ordinance No. 481 or the Amended Environmental Code of the Municipality of Bacnotan. According to Section 2 of the said code, the purpose of creating and passing the code was to ensure proper maintenance, conservation, and protection of the municipality's natural resources and environment from unwanted exploitation and to make sure that it is a safe place for their constituents to live in. Moreover, this code educates their constituents about their roles and responsibilities regarding the proper preservation and management of their own land. This includes staying away from activities that may harm the environment and their health and maximization of recycling of wastes. This is mentioned in the Municipal Ordinance No. 481: Amended Environmental Code of the Municipality of Bacnotan (Damaso, 2016).

The core objective of the study is to help the adjacent barangays address the identified problems in the implementation of their "No Segregation - No Collection" (NSNC) measures based on the local municipal solid waste ordinance in Bacnotan. In doing so, the following extension workflows were observed. First, the approval of the approved extension project. The identification of priority needs would be essential to determine which elements have to address first until all identified problems would be improved. This is to improve the awareness of the participants with regards to collection and transportation of solid wastes, segregation, reduction, reuse, recycle, and disposal. This part is essential because it gauges the knowledge of the respondents on the existence of the NSNC local ordinance and the emerging essential principles behind it. Without knowledge of these principles, no improvement on the implementation of the local ordinance is expected. Furthermore, it can be observed a greater degree of participants' perception was addressed in terms of determining the level of effectiveness in the implementation of the NSNC measures. This section is needed because this is where the reduction of collected household wastes and compliance of households in the community relative to the municipal ordinance was highlighted. As observed in the paradigm of the study, the relationship between the input and the improvement of the respondents' implementation to solid waste management was also

addressed. The arrows pointing inwards show that the main target of the study is to help/guide the three barangays folks using and help sustain and improve the awareness and effectiveness of the the training design and other activities related to "No Segregation, No Collection " local municipal ordinance.

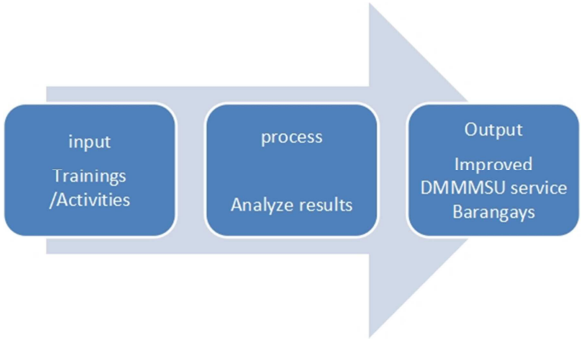

Fig. 1. A conceptual paradigm showing the process of developing extension project

This project intends to assist residents of the three service Barangays of one university in Northern Philippines by conducting orientation, trainings, and other activities on solid waste management and in turn apply the skills learned in reducing waste generated in their surroundings. Beneficiaries will be able to:

1. Acknowledge the importance of solid waste management through series of meeting/seminar/orientation/training/workshop;
2. Learn the different techniques in reducing waste in line with segregation and the 3 Rs through meeting/seminar/orientation/training/workshop;
3. Adopt the best practices of solid waste management;
4. Inspire and implement the policies on waste management through the activity search for the eco-friendliest purok.

Materials and methods

Research design

This extension project employs a participatory action research design, aimed at fostering community engagement and ownership in solid waste management (SWM) initiatives. The participatory approach is instrumental in empowering residents of the identified barangays in La Union, Philippines, to actively contribute to the development and implementation of effective waste management practices. The research design consists of several key phases:

1. Needs assessment: An initial need assessment survey will be conducted to identify the existing knowledge gaps, attitudes, and practices concerning solid waste management among community members. This assessment will serve as the foundation for tailoring the project's educational interventions and ensuring they meet the specific needs and challenges of each barangay.

2. Stakeholder engagement: Engaging various stakeholders, including local government officials, community leaders, and residents, is critical for fostering collaboration and support. Regular meetings will be held to discuss the results of the needs assessment, share research findings, and collaboratively develop action plans for waste management.

3. Capacity Building Workshops: Based on the insights gained from the needs assessment, a series of workshops and training sessions will be organized. These will focus on bioscience principles related to waste management, such as composting techniques, recycling methods, and the benefits of organic gardening. The workshops aim to equip participants with the knowledge and skills necessary to implement sustainable practices within their households and communities.

4. Implementation and Pilot Projects: Following the training sessions, participants will be encouraged to apply what they have learned through pilot projects, such as community gardens and organized clean-up drives. These initiatives will not only serve as practical applications of the training but will also promote collaboration and reinforce community ties.

5. Monitoring and Evaluation: Continuous monitoring and evaluation will be integrated

throughout the project to assess its effectiveness and to gather feedback from participants. This will include pre- and post-intervention surveys to measure changes in knowledge, attitudes, and practices related to solid waste management. Regular evaluation will also allow for adjustments to be made to the project as needed, ensuring its adaptability and sustainability.

6. Documentation and Dissemination: The outcomes of the project will be thoroughly documented, and best practices will be compiled into a guide that can be shared with other barangays and municipalities facing similar challenges. This dissemination of knowledge will contribute to a broader understanding of successful waste management practices and the benefits of community engagement.

Through this structured research design, the project aims to not only address the immediate challenges of waste management in the participating barangays but also to foster a culture of sustainability and environmental stewardship among community members.

Sources of data

The participants of this project were the residents of the three Barangays in La Union, Philippines. The waste management extension project makes use of the "Search for Eco-friendliest Purok" as part of a mass mobilization strategy. A technique known as mass mobilization is engaging and motivating a variety of partners and allies at the national and local levels in order to boost demand for and awareness of a particular development goal. There is an on-site evaluation of the indicators listed in the rubric to choose winner; the extension workers came up with this technique to motivate barangay residents to participate. Aside from the result of the study conducted initial survey was made prior to the launching of the search. The results of the evaluation were used to determine the winner and were utilized to analyze the outcome of the project.

Implementation phase

In the implementation phase. A simple opening program was conducted then a brief communication of results of the study "Effectiveness of the Implementation of the "No Segregation, No Collection Policy: The Case of DMMMSU Service Barangays" was discussed.

A Memorandum of Agreement or Memorandum of understanding was prepared. Followed by the needs assessment survey for the priority areas to be addressed. Meeting with the Barangay officials was called to discuss the result of the needs assessment. Planning with the stakeholders followed. The beneficiaries/clienteles were encouraged to share best practices in their barangays in terms of solid waste management thru an open forum. Orientation was conducted by the extension workers. Monitoring and Evaluation of the participating Purok were done to measure the effectiveness of the service rendered to the beneficiaries/ clienteles.

Results

Project initiation

This extension project was originally an initiative project from the College of Education in 2020. The project was put on hold after the government of the Philippines imposed a state of lockdown in march 2020. The clients/beneficiaries were unable to attend because of the epidemic and all were required to stay at home. Fortunately, in 2021 a limited face to face was allowed. The extension office permitted the extension workers to perform the extension project in the three service Barangays, a neighboring barangay of DMMMSU NLUC. The approved annual and quarterly plans were implemented. The project was launched in the 1st quarter of 2021, the procedures, such as health protocols, getting permits, signing of MOA, meetings, launching, orientation, evaluation were realized. Due to pandemic only the Barangay officials and purok representatives were able to attend the upper mentioned activities and these activities were cascaded by the attendees to the participating purok. Based on the evaluation conducted in 2021, Barangay folks are requesting some face-to-face trainings on the technique

of converting waste into usable things. The team implemented more activities through face-to-face training/activities conducted especially for the SURWEM Agbuo, SURWEM Aglako and SURWEM AgpaAdu endeavors.

Review, monitoring and continual implementation

SURWEM Extension Projects in these three service Barangays commenced in 2023. The training program was already implemented for the three barangays. Lectures on solid waste management and its significance, methods for reducing waste in accordance with segregation and the three Rs, composting and proper waste disposal are all included in the training/seminar/workshop conducted. Through an open forum, the participants were urged to discuss best practices for managing solid waste in their own barangays. The workshops were applied in their Gulayan sa Barangay. Announced and unannounced monitoring were also conducted. A yearly presentation to Agency-In house review were conducted for replanning and to address identified problems.

Discussion

The extension project focused on solid waste management in the three service barangays of one university in the northern Philippines yielded significant results, reflecting the project's effectiveness and community engagement strategies. The results encompass various dimensions, including changes in knowledge, attitudes, behaviors, and community practices related to waste management.

Baseline assessment of knowledge and practices

At the onset of the project, a baseline assessment indicated varying levels of knowledge and practices regarding solid waste management among community members. Many participants demonstrated a lack of awareness about waste segregation, the significance of reducing waste at the source, and the potential benefits of composting.

Quantitative findings: Pre-intervention surveys revealed that only 30% of participants were aware of the proper methods for waste segregation, and less than 25% practiced it consistently. These statistics underscored the urgent need for education and capacity-building initiatives.

Qualitative insights: Focus group discussions highlighted misconceptions about waste management, with many residents believing that all waste could be disposed of similarly, without differentiation between recyclable and non-recyclable materials. Participants also expressed concerns about the impact of waste on community health and the environment, indicating a readiness to engage in change if provided with the necessary tools and information.

Impact of training and workshops

The project included a series of training workshops focusing on solid waste management practices. The pedagogic approach comprised lectures, hands-on activities, and participatory discussions, fostering active learning.

Knowledge improvement: Post-intervention surveys showed a dramatic increase in knowledge; 75% of participants reported understanding the importance of waste segregation after attending the workshops. Additionally, 80% reported feeling confident in implementing waste management practices in their own households.

Behavior change: Observational studies indicated that the percentage of households practicing waste segregation increased from 25% to 65% within three months of the training. Participants adopted techniques learned during workshops, such as composting kitchen waste and creating designated recycling bins.

Community engagement and empowerment

The project fostered a sense of community ownership and responsibility towards sustainable waste management:

Increased participation: Community members took initiative to organize cleanup drives and awareness

campaigns in collaboration with local leaders. Engagement increased notably; the initial training saw an attendance of 40 individuals, which grew to over 100 in subsequent events as word of mouth spread regarding the project's benefits.

Establishment of community groups: The formation of local environmental groups in each barangay provided a platform for ongoing discussions about waste management issues and sustainability practices. These groups facilitated dissemination of knowledge and engaged additional community members, reinforcing a collective commitment to waste reduction efforts.

Creation of sustainable practices

One significant outcome was the establishment of functional community gardens (Gulayan sa Barangay and Backyard Gardening), which served dual purposes of promoting waste reduction and enhancing food security.

Sustainable gardening: The community gardens implemented organic waste recycling through composting, significantly reducing the amount of waste sent to landfills. Notably, the project enabled participants to cultivate vegetables that contributed to local food supplies, enhancing nutrition among participants.

Revolving funds: Some barangays began generating small revolving funds through the sale of excess produce. This financial aspect empowered residents, underscoring the practicality and benefits of sustainable practices.

Long-term sustainability and future directions

The positive outcomes of the project point to a transformative impact on waste management practices within the barangays.

Sustainability plans: Continued monitoring and evaluation mechanisms have been established to ensure that the practices are sustained. Continuous environmental education initiatives are planned, with local leaders taking the lead in organizing periodic workshops and community events.

Policy recommendations: The findings highlight the need for local government policies that support waste management practices. Community feedback suggests that integrating these practices into local governance will encourage compliance and enhance collaboration between residents and officials.

Overall, the extension project achieved important milestones in transforming waste management practices in the three service barangays. By enhancing knowledge, facilitating behavior change, and promoting community engagement, the project laid a foundation for a more sustainable relationship with the environment. Future projects can build on this success, implementing similar strategies in adjacent barangays, and advocating for broader municipal partnerships aimed at addressing solid waste management challenges.

Conclusion

The extension project has not only achieved significant milestones in transforming waste management practices in three service barangays, but it has also highlighted the critical interplay between bioscience and sustainable development. By enhancing community knowledge and facilitating behavioral changes regarding solid waste management, the project underscores the importance of ecological awareness in promoting environmental health. Incorporating bioscience into education and community engagement has ensured that residents understand the biological processes underlying waste decomposition, recycling, and composting. The integration of bioscientific principles, such as nutrient cycling and ecosystem balance, has fostered a deeper appreciation for the environment among community members. This knowledge enables them to recognize their role in sustaining local biodiversity and mitigating pollution, which are essential for the resilience of both human and ecological systems.

Moreover, the establishment of community gardens (Gulayan sa Barangay and Backyard

Gardening) exemplifies the practical applications of bioscience in promoting sustainable agricultural practices. Utilizing organic waste for compost not only reduces landfill contributions but also enriches soil quality, thereby enhancing food production. This dual benefit addresses food security while decreasing negative environmental impacts, aligning with the principles of sustainable development. Looking ahead, the project's success serves as a model for integrating bioscience into community-centered sustainable development strategies. By promoting innovative practices that leverage local resources and enhance ecological knowledge, future initiatives can drive further improvements in waste management while fostering a resilient community ethos. This holistic approach—one that aligns human activities with the health of our ecosystems—will be critical in addressing the complex environmental challenges of our time.

Moving forward, sustained partnerships with local government units, educational institutions, and environmental organizations will be essential. Advocating for policies that incorporate biosciences into waste management and sustainable practices can catalyze broader community actions, promoting integrated solutions that support the well-being of both people and the planet.

In conclusion, this project illustrates the vital connection between effective waste management, bioscience education, and sustainable development. By nurturing a culture of environmental stewardship and embracing sustainable practices supported by scientific understanding, we can pave the way for a healthier, more sustainable future for generations to come.

Recommendations

Based on the conclusions drawn from the extension project, the following recommendations are proposed to further advance the integration of bioscience into solid waste management and promote sustainable development in the community:

1. Incorporate bioscience education in training modules: The College of Education should enhance its community-based training programs by integrating bioscience principles into the curriculum. This includes educating community members about the biological processes of decomposition, nutrient cycling, and the ecological impact of waste. Such knowledge can empower residents to implement sustainable waste management practices effectively.

2. Develop demonstration projects: Establish demonstration gardens that utilize organic waste for composting and promote bio-intensive farming techniques. These projects can serve as practical learning sites where community members observe and engage with sustainable agricultural practices, thereby understanding the connection between waste management and biodiversity conservation.

3. Strengthen collaboration with local environmental scientists: Form partnerships with local bioscientists, universities, and environmental organizations to provide expertise in sustainable practices. These collaborations can help design and deliver specialized workshops that focus on the local ecosystem, the role of biodiversity in waste management, and the benefits of sustainable agricultural practices.

4. Expand community-based research initiatives: Encourage the community to participate in citizen science projects that investigate local waste management issues and biodiversity. Engaging residents in data collection and analysis can enhance their understanding of local ecological systems while fostering a sense of ownership over environmental stewardship initiatives.

5. Promote policies supporting sustainable practices: Advocate for local government policies that emphasize sustainable waste management, including incentives for residents implementing bioscience-based practices such as composting and recycling. Policies could include subsidies for community gardens, educational programs in schools, and public information campaigns about the benefits of waste reduction and biodiversity conservation.

6. Implement monitoring and evaluation processes: Establish robust monitoring and evaluation mechanisms to assess the impact of bioscience education and sustainable practices on waste management outcomes. Regular evaluations can provide valuable insights into the effectiveness of implemented strategies, guiding continuous improvement and adaptation of community programs.

7. Foster a culture of sustainability: Create public awareness campaigns that highlight the significance of the relationship between solid waste management, bioscience, and sustainable development. Utilize local media, workshops, and community events to disseminate information and encourage active participation in sustainability practices.

By addressing these recommendations, the College of Education and community stakeholders can significantly enhance the effectiveness of solid waste management initiatives, ensuring that bioscience and sustainable development principles are integrated into local practices. This holistic approach will not only support community health and environmental resilience but also contribute to global efforts of sustainable development.

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