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Development of Contextualized STEM Lesson on Solid Waste Management Awareness and Practices for Grade Four Learners

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Abstract

Concerns about solid waste management in the Philippines include improper waste disposal, ineffective waste collection, and a shortage of disposal facilities. As a result, the Philippines is regarded as the top plastic polluter in the world. With this, the researcher developed a contextualized STEM Lesson on solid waste management awareness and practices among Grade Four learners and increased the level of solid waste management awareness and their solid waste management practices. The questionnaire has two parts: the level of awareness and the practices in solid waste management. Before the development of the contextualized STEM Lesson, a needs assessment was done for the In-Service Science teachers of the target school. The results served as the basis for the development of the contextualized STEM Lesson on Solid Waste Management Awareness and Practices, which underwent face validation and validation among experts. The developed contextualized STEM Lesson was implemented and the results revealed that learners had gained enough knowledge and awareness in terms of laws and regulations of solid waste, the effect of improper solid waste disposal, solid waste prohibited activities, school initiatives towards solid waste, the importance of solid waste management, and learners' responsibilities. The result also revealed that learners have gained good solid waste management practices in terms of waste disposal, segregation, reduction, reuse, and recycling. The high level of awareness of solid waste management and practices can be attributed to the contextualized STEM Lesson on Solid Waste Management Awareness and Practices. This suggested and revealed that contextualized STEM Lesson on Solid Waste Management Awareness and Practices was an effective tool in fostering high-level awareness and good practices among learners.

Keywords: Solid Waste Management, Awareness, Practices, STEM Lesson

1. Introduction

The Philippines, an archipelagic country in Southeast Asia, is rapidly urbanizing, with a growing middle class and a primarily young population (World Bank, 2020). These dynamic socioeconomic advancements, while promoting growth in the economy, additionally contributed to solid waste management issues. Republic Act No. 9003, also known as the Ecological Solid Waste Management Act of 2000, establishes a comprehensive definition of solid waste and requires systematic management practices at the national and local levels. Iligan City Ordinance No. 09-5488, which aspires to develop a robust and environmentally friendly solid waste management system, strengthens the law's implementation in Iligan City. Despite legislative efforts, improper waste disposal, inadequate collection systems, and insufficient facilities remain persistent issues in many Philippine cities (Climate Change Commission, 2024; Senate Economic Planning Office, 2017). Locally, in Iligan City, the City's Central Material Recovery and Composting Facility (CMRF), upon assessment, there is a need to redevelop it as it has become a warehouse of waste, while some of the composting facilities were not functioning (Sirad, 2023). According to studies, insufficient public engagement and lack of awareness increase these issues, resulting in environmental and health concerns such as pollution, floods, and illnesses (Asian Productivity Organization, 2025; Debrah et al., 2021). The Philippines has also been identified as a key contributor to global plastic pollution (WWF-Philippines, 2018).

Education is typically regarded as a vital approach for addressing these issues. Incorporating solid waste management (SWM) in the school curriculum has been found to increase learner awareness and favorably affect waste management practices (Balaba et al., 2024; Sijbesma & Mozar, 2009). Balubal et al. (2020) discovered that learners who took part in environmental education programs had considerably greater levels of awareness and more responsible attitudes about handling waste. Similarly, Sijbesma and Mozar (2009) emphasized that school-based SWM programs not only teach children about recycling and trash segregation but also encourage analytical abilities, teamwork, and entrepreneurship in learners. A recent study emphasizes the relevance of addressing elementary learners since early educational interventions can impact lifelong attitudes and actions toward the environment (Hoang & Kato, 2017). In research done in Vietnam, environmental education activities dramatically raised elementary learners' understanding of solid waste concerns and their interest in sustainable behaviors (Hoang & Kato, 2017). Furthermore, including environmental themes in core topics has been found to foster a comprehensive grasp of ecological challenges and active engagement in problem-solving.

Despite the acknowledged benefits, most studies and interventions in the Philippines have concentrated on secondary and higher education, leaving a gap at the elementary level (Paghasian, 2017; Gequinto, 2017). To address this, this study aims to develop and implement a contextualized STEM lesson on solid waste management for Grade Four learners, in line with the Science curriculum competencies of showing how to properly dispose of waste based on material properties. STEM education, in particular, provides an effective platform for contextualizing real-world environmental issues like waste management. STEM lessons that engage learners in inquiry-based activities and problem-solving tasks can promote critical thinking, teamwork, and invention (Frontiers in Education, 2023). Integrating circular economy ideas and sustainability principles into STEM courses has been shown to increase learners' responsible consumption and waste reduction behaviors (Kirchherr et al., 2017; Frontiers in Education, 2023). This study intends to improve the dissemination of information and promote sustainable waste management practices among young learners by analyzing their knowledge, sources of information, and practices, therefore contributing to larger environmental and sustainable development goals.

The general objective of this study was to develop a contextualized STEM Lesson on solid waste management awareness and practices among Grade Four learners. Specifically, the following objectives were aimed: (1) develop contextualized STEM lesson on solid waste management awareness and practices among Grade Four learners; (2) determine the level of awareness of the respondents on solid waste management; and (3) describe the respondent's practices on Solid waste management be described in terms of waste disposal, segregation, waste recycling and reuse, and reduction.

2. Methods

2.1 Research Design

The study utilized a quantitative research design using a descriptive approach with a qualitative support. The research population was Grade Four learners in one of the private schools in Iligan City. The samples of this research were thirty-two (32) learners of the said school. These learners were currently enrolled in the academic year 2023-2024. These learners were selected through purposive sampling. Additionally, three in-service science teachers were the participants of the needs assessment to established the need and demand to develop contextualized STEM lesson on solid waste management awareness and practices among Grade Four learners.

2.2 Data Gathering Procedure

The development of the contextualized STEM Lesson on Solid Waste Management Awareness and Practice among Grade Four learners adopted the Input-Process-Output Model (IPO).

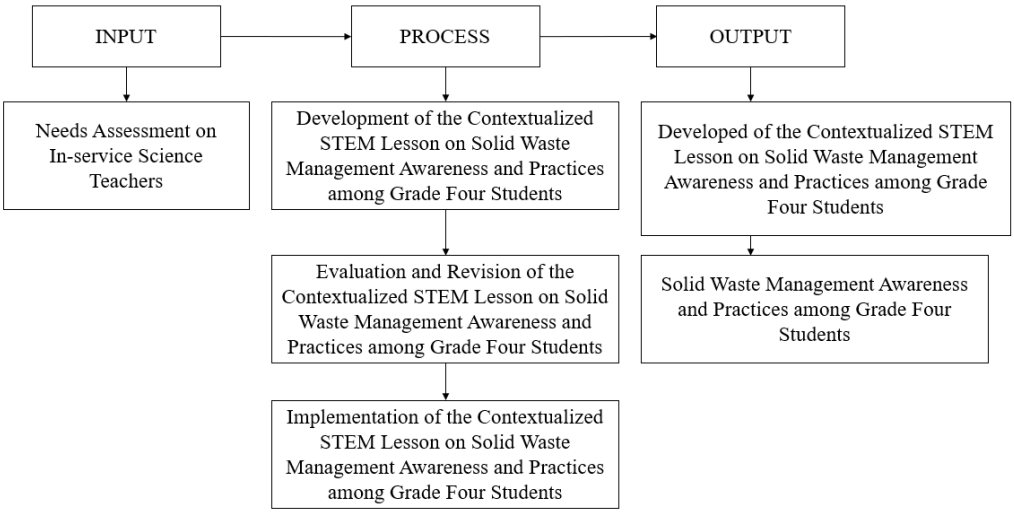

Figure 1. Data Gathering Procedure

Figure 1 shows the data gathering procedure of the study, a needs assessment was conducted through the conduct of interviews using the semi-structured needs assessment which was given to In-service Teachers teaching Science. The in-service science teachers were interviewed and asked about their thoughts on utilizing STEM Lesson on Solid Waste Management Awareness and Practices among Grade Four in their science classes and on how it would benefit them and the learners. This was done to established the need and demand to develop the material. This was then followed by the development of the contextualized STEM lesson on solid waste management awareness and practices among Grade Four learners based on the needs assessment. The development of the

Contextualized STEM lesson includes the making of the STEM Lesson. The lesson was composed of identifying social issues, identifying potential solutions, needing knowledge, decision-making, developing the product, testing and evaluating the solution, and socialization and completing the decision. The activities conducted were included and part of it. After that, the Contextualized STEM lesson on Solid Waste Management Awareness and Practices was evaluated and face-validated by the STEM lesson experts. The STEM lesson experts commented and suggested relevant ideas to further improve the material. A revision and adjustment to the material was made and a final output was developed.

2.3 Data Analysis

For analyzing data from the needs assessment of the in-service science teachers about their thoughts on utilizing STEM Lesson on Solid Waste Management Awareness and Practices among Grade Four in their science classes and on how it would benefit them and the learners, the data coding reliability content analysis was employed where the identification of codes or themes was commonly based on the agreement between the multiple coders or the assigned researchers. Furthermore, the mean was the main statistical tool used to analyze and interpret the level of solid waste management awareness. To interpret the level of solid waste awareness, the following scale ranges were used:

Table 1: Scale Used to Interpret the Level of Solid Waste Management Awareness

Numerical Scale	Weighted Mean Interval Scale	Solid Waste Management Awareness Mean Descriptive Equivalence
4	3.25 – 4.00	Fully Aware
3	2.50 – 3.24	Aware
2	1.75 – 2.49	Partially Aware
1	1.00 – 1.74	Unaware

The mean was also used to analyze and interpret solid waste management practices of the Grade Four learners. To interpret the level of solid waste awareness, the following scale ranges were used:

Table 2: *Interpretation of Solid Waste Management Practices*

Numerical Scale	Weighted Mean Interval Scale	Solid Waste Management Practices Mean Descriptive Equivalence
5	4.21- 5.00	Strongly Agree
4	3.41– 4.20	Agree
3	2.61 – 3.40	Neither Agree or Disagree
2	1.81 – 2.60	Disagree
1	1.00 – 1.80	Strongly Disagree

3. Result

3.1 Semi-structured Needs Assessment: In-service Teachers

The need to develop a Contextualized STEM Lesson on Solid Waste Management Awareness and Practices among Grade Four learners was assessed through the conduct of interviews using the semi-structured needs assessment questionnaire which was given to In-service Teachers teaching Science. The in-service science teachers were interviewed and asked about their thoughts on utilizing STEM Lesson on Solid Waste Management Awareness and Practices among Grade Four in their science classes and on how it would benefit them and the learners.

Based on the responses of the In-Service Teacher (IST) during the semi-structured needs assessment interview about the importance of teaching solid waste management and practices, all of them said that it was necessary, not just because it was mandated to them but also because they knew that it was relevant, especially in their own place, Iligan City.

These in-service teachers have used different pedagogical approaches in teaching the topic of solid waste. Some teachers have used technology such as images, videos, and PowerPoint presentations in order to support the learning process of the learners, while others used different approaches to improve learners' understanding of the topic, such as asking questions to elicit ideas.

Based on the interview, most of the in-service teachers were not familiar with the Contextualized STEM Lesson. Two out of three in-service teachers noted that they do not know and have not used STEM Lesson in their classrooms and the one in-service teacher is not entirely familiar with STEM Lesson for he defined it by just applying science, technology, engineering, and mathematics concepts. This implies that in-service teachers have little idea of the individualized characteristics of a Contextualized STEM Lesson. With this, this implies that there was a need to develop and implement a Contextualized STEM Lesson on Solid Waste Management Awareness and Practices among Grade Four learners.

3.2 Level of Solid Waste Management Awareness

To determine the influence of the teaching approach on the use of the developed STEM lesson on Solid Waste Management Awareness and Practices the gathered data were tallied and tabulated. Mean per item was obtained and mean per competency was computed. The computed mean for both item and competency was interpreted and described by the descriptive statistics.

Table 3: Level of Awareness on Solid Waste Management

Awareness of Solid Waste Management	Weighted Mean	Qualitative Rating
1. I have knowledge about Republic Act No. 9003 or the Ecological Solid Waste Management Act of 2000.	3.5625	Fully Aware
2. I am aware of the Solid Waste Management (SWM) Program of the School.	3.75	Fully Aware
3. I am familiar with the policies of the school's solid waste management program.	3.75	Fully Aware
4. I know the corresponding sanctions for any violations of the Solid Waste Management (SWM) Program.	3.4375	Fully Aware
5. I am properly informed of the purpose of implementing the Solid Waste Management (SWM) Program.	3.6875	Fully Aware
6. I am knowledgeable on possible illnesses that one can get whenever trash is not properly disposed	3.71875	Fully Aware
7. I am aware that before throwing garbage, it is a must to read those trash-can labels for segregation.	3.75	Fully Aware
8. I can distinguish and identify biodegradable from non-biodegradable.	3.6875	Fully Aware
9. I am well-informed on the importance of recycling.	3.8125	Fully Aware
10. I am practicing waste minimization practices like reuse, recycle, and reduce.	3.46875	Fully Aware
Overall Weighted Mean	3.6625	Fully Aware

Table 3 shows the level of awareness among Grade Four learners on solid waste management after the implementation of the Contextualized STEM Lesson on Solid Waste Management Awareness and Practices. As shown in the table, the Grade Four learners

obtained an overall weighted mean of 3.6625 which means that the learners are fully aware of solid waste management after the implementation of the Contextualized STEM Lesson on Solid Waste Management Awareness and Practices. It also showed that they are fully aware of the laws and regulations surrounding solid waste management. Learners who possess a very high or high awareness of laws and regulations are more likely to be able to implement effective solid waste management practices to prevent violations of section 48 of R.A. No. 9003 and shield them from fines or jail time as penalties. Depending on the prohibited act committed, the fine can range from 500 to one million Philippine pesos, and the length of imprisonment can vary from 15 days to 6 years. Apart from this, the learners are also fully aware of the consequences of improper disposal of waste, especially illnesses and solid waste management practices. The result indicates that learners are knowledgeable and fully aware of solid waste management and the material was an effective tool in fostering awareness and knowledge among learners. According to this assessment, the participants in this study were more aware than those in the study of Paghasian (2017). Due to their understanding of the significance of solid waste management, learners are fully aware of their responsibilities. According to a study, learners are prepared to assist and resolve the various issues related to solid waste management at this level, or in elementary school (Lad, Chauhan, & Gole, 2020). Gorman S. and Gorman J. (2018) asserted that people act in particular ways because they are conscious of the circumstances. People who are aware of something will approach it with positivity. People who are unaware of a field may have a bad or neutral opinion of it. Learners' awareness has an impact on their attitude toward waste management because their behavior is influenced by what they know. In addition, one's attitude toward a subject is influenced by their level of knowledge about it (Laor et al., 2017). Waste management attitudes are influenced by a number of factors, including education. The high degree of solid waste management awareness and attitude among respondents may have a beneficial impact on how they dispose of solid waste at home and at school (Madrigal & Oracion, 2018).

3.3 Solid Waste Management Practices

Table 4: Waste Disposal

Waste Disposal	Weighted Mean	Qualitative Rating
1. I dispose of hazardous/toxic/special waste such as chemicals or electronic waste in any garbage container.	2.03	Disagree
2. I throw my waste anywhere as long as no one sees me.	1.53	Strongly Disagree
3. I practice recycling and reusing for recyclable and reusable materials rather than immediate waste disposal.	4.69	Strongly Agree
4. I use aerobic and anaerobic composting for biodegradable waste.	4.44	Strongly Agree
5. I practice the separation of wet waste and dry waste disposal.	4.09	Agree
6. I throw waste materials in common open dumps.	2.44	Disagree
7. I dispose of biodegradable waste in a compost pit.	4.13	Agree
8. I burn waste materials.	1.56	Strongly Disagree
9. I throw and leave my garbage anywhere.	1.41	Strongly Disagree
10. I agree that there will be a sanitary landfill in the nearby area for waste disposal and processing.	3.84	Agree
Overall Weighted Mean	3.02	Neither Agree or Disagree

Table 4 shows the solid waste management practices among learners in terms of waste disposal. As the results are shown in the table, the Grade Four learners obtained an overall weighted mean of 3.015625 having a qualitative description of neither agree nor disagree. These results imply that they have good waste disposal practices. For instance, on indicators 2, 8, 9, 1, and 6 which were bad waste disposal practices the learners obtained a mean of 1.53125, 1.5625,1.40625, 2.03125, and 2.4375 respectively, and had a qualitative description of strongly disagree and disagree. While on indicators 3,4,5,7, and 10 which were good waste disposal practices the learners obtained a mean of 4.6875, 4.4375, 4.09375, 4.125, and 3.84375 respectively. These indicators have a qualitative description of strongly agree and agree. This implies that not only did the material increase the solid waste management awareness of the learners but also the learners' ability to dispose their waste properly. These results revealed that the contextualized STEM lesson was an effective material in enhancing waste disposal practices. Molina and Catan (2021) obtained the same results. Likewise, the outcome suggests that learners dispose of their waste properly. For example, learners consistently dispose of solid waste properly in the designated trash cans.

Table 5: Segregation, Waste Recycling and Reuse, and Waste Reduction

Segregation, Waste Recycling and Reuse, and Waste Reduction	Weighted Mean	Qualitative Rating
1. I separate biodegradable (paper, banana peels, cardboard, and vegetables and non-biodegradable (plastic toys, glass, steel, rubber) waste at school.	4.66	Strongly Agree
2. I mix all the garbage in one container.	1.5	Strongly Disagree
3. I am reading the waste bin label before throwing garbage.	4.69	Strongly Agree
4. I practice proper waste segregation to serve as a model for others and to influence others.	4.56	Strongly Agree
5. I convert or redesign waste materials into a new product.	4.53	Strongly Agree
6. I reuse my old materials (grocery bags, food containers) rather than buying new ones.	4.63	Strongly Agree
7. I kept those unfilled papers and used it as a scratch.	4.44	Strongly Agree
8. I always bring packed lunches in a reusable lunchbox.	4.72	Strongly Agree
9. I buy only what I need so that I will not end up throwing away extra food.	4.63	Strongly Agree
10. It is awkward to bring a container when buying cooked food for take-out.	2.81	Neither Agree or Disagree
Overall Weighted Mean	4.12	Agree

Table 5 shows the solid waste management practices among learners in terms of Segregation, Waste Recycling and Reuse, and Waste Reduction. Segregation as defined in Article 2, Sec. 3 of R.A. No. 9003, pertains to the process of separating materials from their origin in order to facilitate recycling, reuse of materials and reduce waste generation. Recycling as defined in Article 2, Sec. 3 of R.A. No. 9003 pertains to the treating of waste material by converting them into a new product. Reuse as defined in Article 2, Sec. 3 of R.A. No. 9003 pertains to the recovery of materials that have the same or different usage without changing their physical and chemical characteristics. Reduction is the most preferred way of solid waste management. Doing reduction saves natural resources, reduces the toxicity of waste, and reduces costs.

Data shows that the learners obtained an overall weighted mean of 4.115625 and with a qualitative description of agree. This result implies that learners have good solid waste management practices in terms of segregation, Waste Recycling and Reuse, and Waste Reduction. On indicators 1,3, and 4 which were the good waste segregation practices the

learners garnered a mean of 4.65625, 4.6875, and 4.5625 respectively. This means that the learners have a qualitative description of strongly agreeing and have a good segregation practice. Whereas, on indicator 2 which was a bad segregation practice the learners obtained a mean of 1.5 and had a qualitative descriptor of strongly disagree. This indicated that the learners disapproved of and disliked this practice.

On indicators 5,6,7,8, and 9 which were the proper waste recycling and reuse, and waste reduction practices the learners obtained a mean of 4.53125, 4.625, 4.4375, 4.71875, and 4.625 respectively. These indicators had a qualitative description of strongly agree. This implies that learners have good waste recycling and reuse, and waste reduction practices. Whereas, on the contrary on indicator 10 the learner obtained a mean of 2.8125 and had a qualitative description of neither agree nor disagree. This indicates that learners are neither agreeing nor disagreeing on bringing containers when buying food for takeout. These results suggested that contextualized STEM lesson on solid waste management foster good practices while rejecting bad practices in segregating, reducing, recycling, and reusing waste. Molina and Catan (2021) obtained identical results. In a similar manner, the result suggests that learners are following appropriate procedures for reducing, recycling, and reusing solid waste. Learners who practice reduction use reusable containers, eco-bags, and limited purchases of essential items. Using scrap paper to solve problems in math class and cleaning up food and water containers are a couple of the practices. Learners who practice recycling always turn used materials into new ones.

4. Conclusion

This study implemented a contextualized STEM Lesson on Solid Waste Management Awareness and Practices among Grade Four learners. Results revealed that learners had gained enough knowledge and awareness in terms of laws and regulations of solid waste, the effect of improper solid waste disposal, solid waste prohibited activities, school initiatives towards solid waste, the importance of solid waste management, and learners' responsibilities. The result also revealed that learners have gained good solid waste management practices in terms of waste disposal, segregation, reduction, reuse, and recycling. The high level of awareness of solid waste management and practices can be attributed to the contextualized STEM Lesson on Solid Waste Management Awareness and Practices. This suggested and revealed that contextualized STEM Lesson on Solid Waste Management Awareness and Practices was an effective tool in fostering high level awareness and good practices among learners.

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