J-IAMSTEM
Journal of Innovation, Advancement, and Methodology in STEM Education
Vol. 2, No. 5, pp. 391-415, September-October 2025
https://so13.tci-thaijo.org/index.php/j_iamstem

Awareness and Practices on Solid Waste Management among Junior High School Students: Basis a Contextualized STEM Lesson

Lea E. Salon and Monera A. Salic-Hairulla
Mindanao State University - Iligan Institute of Technology, Iligan City, Philippines
*Corresponding author's E-mail address: lea.salon@g.msuiit.edu.ph, monera.salic@g.msuiit.edu.ph

Received: 6 Feb 2025 Revised: 19 Sep 2025 Accepted: 28 Sep 2025

Abstract

This study investigates the level of awareness and practices related to solid waste management among junior high school students, aiming to establish a foundation for a contextualized STEM lesson. Using a descriptive survey method, data were collected to assess their knowledge, attitudes, and behaviors regarding waste segregation, recycling, and environmental responsibility. Findings revealed high awareness among students (G7-10) regarding solid waste concepts, their impacts, prohibited activities, community initiatives, and their roles—mainly informed by media, school campaigns, and teachers. However, students have limited knowledge of the laws regulating solid waste management and recycling. These insights informed the development of a STEM lesson plan tailored to local environmental challenges, promoting active student engagement and sustainable habits through crafting a prototype from recycled material.

Keywords: Awareness, Practices, Solid Waste Management

1. Introduction

Waste is a natural part of the human life cycle and is produced in different forms, such as bodily waste, solid waste, hazardous waste, and even e-waste (The Environmental Literacy Council, 2015). Among these, solid waste is one of the most voluminous types produced globally (Hoornweg & Bhada-Tata, 2012). Solid waste is defined as the unwanted and discarded materials produced from day-to-day human activities (Mishra et al., 2014). This includes "yard waste, food waste, plastics, wood, metals, papers, rubbers, leather, batteries, inert materials, textiles, paint containers, demolishing and construction materials, as well as many others that would be difficult to classify" (Abdel-Shafy & Mansour, 2018).

At present, solid waste and its management are considered to be global problems (Singh et al., 2014). It is predicted that by 2025, the global population will increase to eight billion, and by 2050, there will be a further increase to 9.3 billion, out of which approximately seventy percent of the population will reside in urban locations. In addition, it is predicted that each individual will increase the amount of municipal solid waste they

produce due to urbanization and increased industrialization. Numerous developing countries have remained underdeveloped in their solid waste management systems.

In the Philippines, an estimated amount of 35,580 tons of garbage per day is generated (Castillo & Otoma, 2013) or about 14.66 million tons annually in 2014 (Department of Environment and Natural Resources [DENR], 2018). It has increased to 16.6 million tons based on the 2018 data, making the Philippines the "third-largest generator of solid waste per year among Southeast Asian countries" (Romero, 2020). Increasing population, leveling up of living standards, and urbanization are the leading factors associated with excessive waste (Senate Economic Planning Office [SEPO], 2017).

The situation of the Philippine environment has reached critical proportions concerning solid waste management that needs immediate and collective action from all sectors of the government. The enactment of RA 9003, otherwise known as the Ecological Solid Waste Management (ESWM) Act of 2000, provides for an Ecological Solid Waste Management Program creating the necessary institutional mechanisms and incentives, declaring certain acts prohibited and providing penalties, appropriating funds and for other purposes (Azuelo, 2016). This law includes activities, penalties, and features focused on overcoming and addressing the challenges of waste management.

Solid waste management as defined by Marello and Helwege (2014), is the collection, transport, processing, recycling, or disposal of waste materials. It is the materials produced by human activity and is generally undertaken to reduce their effect on health, aesthetics, or amenity. Waste management is also carried out to reduce the materials' effect on the environment and to recover resources from them. It can also involve solid, liquid, or gaseous substances, with different methods and fields of expertise for each essential.

Poor solid waste management will lead to various problems in health, the environment, and socio-economic aspects. From this issue, a gap between the implementation and practices, especially for the young generation, is undeniable. Most of them are exposed to gadgets and the use of social media as part of their daily lives without giving a care for the environment. And so, proper waste segregation is not well practiced but relies on the technology instead (Gantang, 2022).

While the study recommends integrating solid waste management into STEM lessons, it also clearly articulates how this approach addresses students' limited understanding of waste management laws and recycling practices. According to Timbangan et al. (2025), contextualized STEM lessons significantly enhance students' awareness and practices in solid waste management, including knowledge of relevant laws and responsible behaviors. Similarly, Molina and Catan (2021) found that although students are generally aware of basic waste concepts, their understanding of legal frameworks and recycling remains limited. Integrating these topics into STEM education can bridge this gap by fostering critical thinking, problem-solving, and environmental literacy. As Patahuddin (2024) emphasizes, STEM-based instruction empowers students to tackle real-world waste challenges innovatively, cultivating proactive habits and deeper engagement with environmental issues. Therefore, a clearer pedagogical framework linking STEM competencies with solid waste management objectives would strengthen the study's recommendations and ensure meaningful learning outcomes.

2. Methodology

2.1 Target Group

The respondents of the study were the two hundred twenty-two (222) Junior High School students enrolled in the school year 2022-2023 from Rizal National High School, Claveria West district, Misamis Oriental, Philippines.

2.2 Methods of Inquiry

This study employed a descriptive quantitative research design to assess the awareness and practices of Junior High School students regarding solid waste management. The primary method of inquiry involved the use of a structured survey questionnaire, through the adopted instrument of Molina and Catan (2021) on the Solid Waste Management Awareness and Practices Questionnaire (SWMAPQ) covering key areas such as definitions, effects of improper disposal, prohibited activities, community initiatives, and students' roles, and was distributed across Grades 7 to 10 levels. Data were analyzed using descriptive statistics, specifically mean scores and composite means, to interpret the degree of awareness and engagement among respondents. The study also explored the sources of awareness, such as media, school campaigns, and peer influence, and identified gaps in knowledge, particularly in understanding environmental laws and recycling practices. This method allowed for a comprehensive snapshot of student behavior and perceptions, providing a strong foundation for recommending targeted interventions and STEM-based strategies to enhance environmental education. Contextualized STEM Lesson on Solid Waste Management was developed regarding Sutaphan and Yuenyong (2019) STEM education pedagogical framework as showed in appendix.

2.3 Ethical Consideration

This study adhered to ethical standards in conducting research with human participants. Before data collection, informed consent was obtained from all student respondents and their guardians, ensuring voluntary participation. Participants were assured of the confidentiality and anonymity of their responses and that the data collected would be used solely for academic purposes. The study also respected the rights and welfare of the students by avoiding any form of coercion or harm. Approval from the school administration was secured, and all procedures complied with institutional and educational research guidelines.

Table 1: Interpretation of Solid Waste Management Awareness and Practice Questionnaire (Molina & Catan, 2021)

Rate	Solid Waste Management Awareness	Sources of Solid Waste Management Awareness	Solid Waste Management Practices
3.25 - 4.0	Very High (VH)	Very Great Extend (VGE)	Always (A)
2.50 - 3.24	High (H)	Great Extent (GE)	Often (O)
1.75 - 2.49	Low (L)	Less Great Extent (LGE)	Seldom (S)
1.00 - 1.74	Very Low (VL)	Least Great Extent (LtG)E	Never (N)

3. Research Findings

Solid Waste Management Awareness

The level of solid waste management awareness was measured into seven (7) indicators: solid waste definition; effects of solid waste due to improper disposal; relevant laws regulating solid waste management; solid waste prohibited activities; school/ community intervention on solid waste management; importance of solid waste management; and responsibilities of the respondents.

Table 2: Definition of a Solid Waste

STATEMENT	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
As a Junior High School student, I am aware of/on/that	WM	DR	WM	DR	WM	DR	WM	DR
1. solid wastes are								
a. Agricultural waste	3.26	VH	3.29	VH	3.31	VH	3.33	VH
b. Construction debris	3.11	H	3.11	H	3.13	H	3.15	H
c. Commercial waste	3.10	H	3.13	H	3.15	H	3.17	H
d. Street sweepings	3.12	H	3.15	H	3.18	H	3.20	H
e. Discarded from households	3.25	VH	3.25	VH	3.27	VH	3.28	VH
f. Non-hazardous industrial waste	2.50	H	2.52	H	2.54	H	2.54	H
Composite Mean	**3.05**	**H**	**3.075**	**H**	**3.09**	**H**	**3.11**	**H**

The table presents junior high school students' self-reported awareness of various types of solid waste across Grades 7 to 10. The composite mean scores range from 3.05 to 3.11, indicating a high level of awareness (H) overall. Notably, students consistently rated agricultural waste and household waste with very high awareness (VH) across all grade levels, while other categories, such as construction debris, commercial waste, street sweepings, and non-hazardous industrial waste, were rated with high awareness.

This suggests that students are most familiar with waste types they encounter in daily life, particularly household and agricultural waste, which are common in both urban and rural Filipino communities. According to Mishra et al. (2014), solid waste includes a wide array of materials generated from human activities, and familiarity tends to be higher for waste types that are visible and directly experienced. The Environmental Literacy Council (2015) also notes that awareness of waste is shaped by its proximity to everyday life, such as food scraps, packaging, and yard waste.

The consistently high scores across grade levels reflect the effectiveness of early environmental education and community exposure. As Molina and Catan (2021) observed, students often gain awareness through school campaigns, media, and local initiatives, which emphasize common waste categories and their environmental impact. However, the relatively lower scores for non-hazardous industrial waste (mean scores around 2.50) suggest limited exposure to industrial processes and their byproducts, an area less emphasized in basic education and less visible to students.

These findings align with Timbangan et al. (2025), who argue that while students may understand basic waste categories, deeper knowledge of specialized or regulatory classifications requires targeted instruction. Integrating these concepts into STEM lessons can help bridge the gap by connecting scientific principles with real-world waste management challenges, encouraging students to explore less familiar waste types through inquiry-based learning.

Panganiban-Santos & Pastrana (2021), in their study conducted in Bulacan, examined the relationship between students' awareness and their actual waste management practices. They found that while students exhibited high awareness of solid waste concepts, such as its definition, environmental effects, and proper disposal, their understanding of waste management laws and long-term sustainability strategies remained limited. This gap between awareness and deeper knowledge mirrors the findings of this study, where junior high school students showed high awareness of common waste types and their roles, but lacked familiarity with legal frameworks and recycling systems.

Both studies highlight that students are aware of what solid waste is and why it matters, but struggle to apply this knowledge in more technical or policy-driven contexts.

Table 3: Awareness of the Effects of Improper Waste Disposal

STATEMENT	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
As a Junior High School student, I am aware of/on/that	WM	DR	WM	DR	WM	DR	WM	DR
2. improper of waste may lead to								
a. clogging of drainage canals that will lead to floods during rainy season	3.28	VH	3.29	VH	3.33	VH	3.34	VH
b. Breeding or shelter of pests such as flies, rats and mosquitoes.	3.13	H	3.16	H	3.30	VH	3.32	VH
c. Human illnesses	3.14	H	3.16	H	3.16	H	3.25	VH
d. Degradation or destruction on environment such as pollution	3.15	H	3.25	VH	3.26	VH	3.27	H
e. Serious threat on animals	3.11	VH	3.13	H	3.15	H	3.16	H
Composite Mean	**3.16**	**H**	**3.20**	**H**	**3.24**	**H**	**3.26**	**VH**

Table 3 emphasizes that junior high school students across Grades 7 to 10 exhibit a high to very high level of awareness regarding the consequences of improper waste disposal. The composite mean scores show a gradual increase from 3.16 (Grade 7) to 3.26 (Grade 10), indicating that students' understanding of waste-related impacts becomes more refined as they progress through school.

Clogging of drainage canals leading to floods received the highest awareness scores across all grade levels (3.28–3.34, Very High). This reflects students' familiarity with a common and visible consequence of poor waste disposal, especially in urban areas like Cagayan de Oro, an adjacent city to the respondents' residences, which are prone to flooding during the rainy season. Breeding of pests (flies, rats, mosquitoes) and human illnesses also scored high to very high, particularly in Grades 9 and 10, indicating growing awareness of health-related risks. Environmental degradation and threats to animals were consistently rated high, though slightly lower, suggesting that ecological impacts may be less emphasized in early education.

WHO Expert Committee Report highlights that improper waste disposal contributes to urban flooding, vector-borne diseases, and water contamination, especially in developing countries. It advocates for early education to prevent these public health risks Gautam et al. (2010). This report supports the students' high awareness of flooding and disease as direct consequences of waste mismanagement.

Furthermore, the study of Molina & Catan (2021), found that students are highly aware of visible and immediate effects of waste, such as pollution and pest infestation, but less informed about long-term ecological damage and legal implications. The result of their study explains why awareness of flooding and health risks is higher than awareness of environmental degradation or threats to animals. High awareness of environmental consequences shows that students are well-informed about how waste affects their surroundings, especially through flooding and health risks.

The education sector plays an important role in nurturing the responsibility of proper waste disposal. The Environmental Literacy Council (ELC), a U.S.-based organization dedicated to improving environmental education through science-based resources. In their 2015 publication on waste and human impact, the Council emphasizes that waste is a natural byproduct of human life, generated in various forms such as bodily waste, solid waste, hazardous waste, and electronic waste (e-waste). The report highlights the

importance of understanding not just what waste is, but how it affects human health, ecosystems, and community well-being. The Council also stresses that education plays a critical role in shaping responsible waste behavior. It advocates for integrating environmental topics into school curricula to help students recognize the cause-and-effect relationships between improper waste disposal and issues like pollution, disease, flooding, and biodiversity loss. Validating students' understanding of waste as a multifaceted issue. The Council's broad definition of waste aligns with the respondents' awareness of different waste types and their consequences. The junior high school students recognized pollution and threats to animals as outcomes of poor waste management, which the Council identifies as key ecological concerns. Emphasizing the role of education, the Council argues that schools must go beyond basic awareness and equip students with the tools to analyze, evaluate, and solve environmental problems, which can be possible through contextualized STEM lessons.

Awareness of Solid Waste Management Laws and Ordinances

Table 4: Relevant Laws Regulating Solid Waste Management

STATEMENT **As a Junior High School student, I am aware of/on/that**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
3. different laws or ordinances relevant to solid waste management, such as								
a. Presidential Decree No. 825	1.71	VL	1.74	VL	2.44	L	2.45	L
b. R.A. No. 9003	2.44	L	2.48	L	2.47	L	2.48	L
c. R.A. No. 8749	2.44	L	2.45	L	2.47	L	2.49	L
d. R.A. No. 9275	2.41	L	2.43	L	2.46	L	3.15	H
e. Municipal/Barangay Ordinance	2.50	H	2.52	H	3.11	H	3.16	H
Composite Mean	**2.3**	**L**	**2.32**	**L**	**2.16**	**L**	**2.29**	**L**

The findings reveal that junior high school students across all grade levels possess limited knowledge of national legislation and presidential mandates related to solid waste management. This is reflected in the consistently insufficient mean scores for items referencing Presidential Decree No. 825, Republic Act No. 9003 (Ecological Solid Waste Management Act of 2000), RA 8749 (Clean Air Act), and RA 9275 (Clean Water Act). The composite mean scores, ranging from 2.16 to 2.32, fall within the "Minimal" category, indicating a significant gap in students' understanding of the legal frameworks that govern environmental protection in the Philippines.

The limited knowledge of solid waste management laws among respondents can be attributed to the lack of emphasis and integration of these legal frameworks within classroom instruction. As noted by Debrah et al. (2021), the absence of explicit discussion on relevant environmental legislation in the curriculum contributes to students' ignorance of the significance of these laws in promoting a clean and sustainable environment. Consequently, students must be exposed to and educated about key policies such as Presidential Decree No. 825 and Republic Acts 9003, 8749, and 9275. This need is further underscored by the National Solid Waste Management Status Report (2008–2014), which advocates for the inclusion of legal and policy components in environmental education. The findings imply that educators should actively incorporate these laws into their lessons using an innovative approach to enhance students' legal literacy and foster responsible environmental citizenship.

In contrast, students demonstrated higher awareness of local ordinances, particularly municipal and barangay regulations, with scores reaching High levels among Grade 9 and Grade 10 respondents. This suggests that community-level initiatives and localized enforcement are more visible and accessible to students, contributing to greater familiarity. A particularly notable finding is the consistently limited awareness of Presidential Decree No. 825, which mandates proper waste disposal and penalizes littering. With mean scores ranging from 1.71 to 2.45, this decree registered the least of awareness among all legal references assessed, especially among Grade 7 and Grade 8 students. This points to a critical gap in foundational environmental legal literacy among younger learners, underscoring the need for targeted educational interventions, such as a STEM-based approach with a contextualized discipline with a functional transfer of knowledge that integrates legal concepts into classroom instruction.

Awareness of Prohibited Waste Disposal Activities

Table 5: Solid Waste Prohibited Activities

STATEMENT **As a Junior High School student, I am aware of/on/that**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
4. Following prohibited activities such as								
a. Littering, throwing, or dumping of waste in public places such as roads, esteros, etc.	3.19	H	3.21	H	3.22	H	3.23	H
b. Open burning of leaves and plastics	3.21	H	3.22	H	3.23	H	3.25	H
c. Open dumping of waste in flood-prone areas	3.22	H	3.22	H	3.23	H	3.25	H
d. Mixing of solid waste in any waste box or receptacle.	3.23	H	3.23	H	3.24	H	3.24	H
Composite Mean	**3.21**	**H**	**3.22**	**H**	**3.23**	**H**	**3.24**	**H**

Table 5 shows that junior high school students across all grade levels exhibit a high awareness regarding prohibited activities related to solid waste disposal. The composite mean scores range from 3.21 (Grade 7) to 3.24 (Grade 10), consistently falling within the "High" category. This suggests that students are generally well-informed about common violations of waste management practices, likely due to their visibility in everyday community settings and reinforcement through school campaigns. Specifically, activities such as littering and dumping waste in public areas, including roads and esteros, received mean scores ranging from 3.19 to 3.23, reflecting strong recognition of these behaviors as environmentally harmful and socially unacceptable. Similarly, practices such as the open burning of leaves and plastics, dumping waste in flood-prone zones, and the mixing of solid waste in receptacles were rated highly (mean scores between 3.21 and 3.25), suggesting that students are well-informed about the negative consequences associated with these actions. These findings imply that awareness of visible and commonly encountered violations is well-established among learners, likely due to reinforcement through school programs, community ordinances, and media exposure.

Republic Act No. 9003, also known as the Ecological Solid Waste Management Act of 2000, establishes a comprehensive framework for managing solid waste in the Philippines. It explicitly prohibits environmentally harmful practices such as littering, open dumping, and open burning of waste, while mandating proper segregation,

collection, and disposal procedures. The law also emphasizes the importance of community participation and local government involvement in implementing sustainable waste management systems. Interestingly, while students demonstrate familiarity with the prohibited actions outlined in the law, their recognition of RA 9003 by name remains limited, as reflected in the low mean scores for legal awareness. This suggests that the practical components of the law are being effectively communicated through local ordinances, school campaigns, and community initiatives, even if the formal legislative references are not emphasized in classroom instruction.

This gap between behavioral awareness and legal literacy highlights the need for curriculum integration of environmental laws, as supported by the National Solid Waste Management Status Report (2008–2014). Embedding legal frameworks into STEM and social science lessons can help students understand not only what actions are prohibited, but also why these laws exist and how they contribute to sustainable development. As Debrah et al. (2021) emphasize, the absence of legal content in educational materials contributes to students' limited understanding of the role of legislation in maintaining a clean and healthy environment.

The results of this study indicate that junior high school students exhibit a high level of awareness regarding prohibited waste disposal practices, such as littering, open burning, and improper dumping. This behavioral awareness is consistent with the findings of Molina and Catan (2021), who observed that students are particularly conscious of visible and community-based violations due to their frequent exposure in everyday settings. According to their study, this heightened awareness is largely shaped by school-led initiatives, media reinforcement, and local ordinances, which emphasize practical waste management behaviors. However, both studies reveal a common gap in which, while students recognize what actions are harmful and prohibited, they often lack deeper legal knowledge of the national laws that govern these behaviors. This suggests that environmental education tends to focus more on observable practices than on the legislative frameworks that underpin them. To address this, it is essential to integrate environmental laws into formal instruction, thereby strengthening students' legal literacy and empowering them to become informed and responsible environmental stewards.

This finding directly supports the results of the present study, which show that the respondents are similarly more familiar with prohibited activities they regularly observe, such as dumping waste in public areas and mixing waste in receptacles. However, despite this behavioral awareness, both studies highlight a notable gap in students' legal literacy, particularly regarding national laws like Republic Act No. 9003 and Presidential Decree No. 825. This suggests that while students understand what actions are harmful, they may not fully grasp the legal foundations that prohibit such behaviors, underscoring the need to integrate environmental legislation using a STEM-based approach into classroom instruction to strengthen both knowledge and civic responsibility and produce a tangible and functional learning product/prototype.

The results of the study highlight a critical gap between students' behavioral awareness and their legal and conceptual understanding of solid waste management. A STEM-based approach is necessary to bridge this gap by integrating scientific inquiry, technological innovation, and civic responsibility into environmental education. STEM lessons can contextualize laws like RA 9003 through real-world applications, such as waste audits, pollution analysis, and engineering challenges. Timbangan et al. (2025) demonstrated that contextualized STEM instruction significantly improves students' understanding of waste laws and practices. By embedding legal frameworks into science and technology activities, students can develop deeper knowledge, critical thinking skills, and a stronger sense of environmental stewardship.

Awareness of School and Community Initiatives on Solid Waste Management

Table 6: School/Community Intervention on Solid Waste Management

STATEMENT **As a Junior High School student, I am aware of/on/that**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
5. school/community initiatives such as								
a. having solid waste management program	3.18	H	3.22	H	3.24	H	3.24	H
b. having policies on solid waste management program	3.22	H	3.23	H	3.23	H	3.24	H
c. having sanction on violating the school's solid waste management policy	3.21	H	3.21	H	3.23	H	3.24	H
Composite Mean	**3.20**	**H**	**3.22**	**H**	**3.23**	**H**	**3.24**	**H**

Table 6 indicates that junior high school students across all grade levels exhibit a high level of awareness regarding school and community-based initiatives on solid waste management. The composite mean scores range from 3.20 (Grade 7) to 3.24 (Grade 10), consistently falling within the "High" category. This suggests that students are well-informed about the presence of structured programs, policies, and sanctions within their educational and local environments. Specifically, awareness of the existence of a solid waste management program within their school or community scored between 3.18 and 3.24, suggesting that students recognize and acknowledge the presence of organized efforts aimed at promoting proper waste disposal practices.

Similarly, awareness of policies governing waste management received high ratings (mean scores ranging from 3.22 to 3.24), reflecting students' familiarity with institutional rules and guidelines that regulate waste-related behavior. Moreover, awareness of sanctions for violating waste policies was also rated highly (3.21–3.24), indicating that students understand the consequences of non-compliance and appreciate the role of enforcement mechanisms in maintaining environmental discipline.

Collectively, these findings imply that students are not only exposed to environmental programs but also perceive them as active, structured, and relevant components of their school and community life. This level of awareness underscores the effectiveness of localized environmental initiatives and suggests that institutional engagement plays a significant role in shaping students' attitudes and behaviors toward solid waste management. Hence, this result corroborates to the study of Punongbayan et al. (2014) pointing out that faculty are the promoters and leaders in the implementation of solid waste management programs in which dissemination is carried out through the efforts of the Supreme Student Government officials.

The National Solid Waste Management Status Report (2008–2014) further emphasizes the role of educational institutions in promoting environmental responsibility through policy development and disciplinary measures. Additionally, Molina and Catan (2021) found that students are more familiar with community-level programs than national laws, due to the visibility and direct impact of local initiatives. This reinforces the

importance of embedding environmental practices within school systems to cultivate responsible behavior and civic engagement among learners.

Based on the findings in which students across all grade levels show high awareness of school and community, initiatives related to solid waste management, including the presence of programs, policies, and sanctions. This indicates that learners recognize these efforts as active and relevant parts of their environment. However, while they understand what is being done, they may lack deeper insight into the scientific and legal foundations behind these practices. A STEM-based approach is necessary to bridge this gap by integrating scientific inquiry, technological innovation, and civic understanding into the curriculum. Through STEM, students can explore the environmental impact of waste, design solutions, and connect policies to real-world outcomes. This approach not only reinforces existing awareness but also empowers students to become informed, innovative, and responsible contributors to sustainable waste management.

Awareness of the Importance of Solid Waste Management

Table 7: Importance of Solid Waste Management

STATEMENT **As a Junior High School student, I am aware of/on/that**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
6. The importance of solid waste management								
a. key to achieving a clean and green environment	3.21	H	3.23	H	3.29	VH	3.31	VH
b. reduce the reproduction of pests	3.10	H	3.13	H	3.20	H	3.22	H
c. protect public health	3.11	H	3.14	H	3.15	H	3.26	VH
Composite Mean	**3.14**	**H**	**3.16**	**H**	**3.21**	**H**	**3.26**	**VH**

Table 7 reveals that the junior high school students across all grade levels exhibit a consistently high to very high level of awareness regarding the importance of solid waste management (SWM). The composite mean scores range from 3.14 (Grade 7) to 3.26 (Grade 10), indicating a progressive increase in understanding as students advance through grade levels. This trend suggests that learners increasingly recognize the critical role of SWM in promoting environmental sustainability, public health, and community well-being.

Specifically, awareness of SWM as a key to achieving a clean and green environment scored between 3.21 and 3.31, with Grade 9 and Grade 10 students reaching the "Very High" category. This reflects students' recognition of SWM as a foundational practice in maintaining ecological balance and aesthetic cleanliness. Similarly, awareness of SWM's role in reducing the reproduction of pests, such as flies, rats, and mosquitoes, remained consistently high (3.10–3.22), indicating that students understand the link between unmanaged waste and vector-borne diseases. Awareness of SWM's function in protecting public health also scored high to very high (3.11–3.26), suggesting that students associate proper waste disposal with disease prevention and community safety.

These findings imply that students are not only aware of the visible benefits of SWM but also understand its broader implications for health and environmental quality. This level of awareness aligns with the provisions of Republic Act No. 9003 (Ecological Solid Waste Management Act of 2000), which emphasizes the importance of proper waste management in achieving a clean and healthy environment through segregation, recycling, and community participation. The World Health Organization (2010) also underscores that

improper waste disposal contributes to the spread of infectious diseases and environmental degradation, reinforcing the role of SWM in public health protection.

Furthermore, Molina and Catan (2021) found that students are highly aware of the practical benefits of solid waste management, such as cleaner surroundings and reduced pest infestation. However, they noted that deeper understanding of systemic and legal aspects remains limited. This reinforces the need to build on students' existing awareness by integrating SWM into more comprehensive and inquiry-based learning experiences.

In light of these findings, a STEM-based approach is necessary to deepen students' understanding of SWM beyond surface-level awareness. Through scientific inquiry, technological innovation, and civic engagement, students can explore the environmental impact of waste, design solutions, and connect policies to real-world outcomes. This approach not only reinforces existing knowledge but empowers students to become informed, innovative, and responsible contributors to sustainable waste management.

Awareness of Solid Waste Management Roles and Responsibilities

Table 8: Role and Responsibilities in Solid Waste Management

STATEMENT **As a Junior High School student, I am aware of/on/that**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
7. my role and responsibilities such as								
a. reduce the waste generated	3.19	H	3.20	H	3.23	H	3.24	H
b. clean as you go or CLAYGO	3.13	H	3.16	H	3.20	H	3.28	VH
c. segregate waste when disposing based on trashcan labels	3.14	H	3.16	H	3.19	H	3.24	H
d. compost organic waste	3.15	H	3.17	H	3.22	H	3.23	H
e. recycle waste into a new product	3.11	H	3.13	H	3.18	H	3.16	H
f. refuse single used items	2.44	L	2.46	L	3.19	H	3.20	H
g. reuse items	3.10	H	3.11	H	3.19	H	3.21	H
Composite Mean	**3.04**	**H**	**3.06**	**H**	**3.2**	**H**	**3.22**	**H**

Table 8 presents the roles and responsibilities of Junior High School students in relation to solid waste management. The data reveal that most respondents exhibit a high level of awareness regarding their tasks and responsibilities in practicing sustainable waste management. Specifically, practices such as reducing waste generation, adhering to the Clean As You Go (CLAYGO) principle, segregating waste according to designated trash can labels, composting organic waste, recycling materials into new products, and reusing items are areas where students across all grade levels consistently demonstrate high awareness.

However, the practice of refusing single-use items shows notably limited awareness among Grade 7 and Grade 8 students. This gap may be attributed to the insufficient background knowledge among younger students regarding the environmental consequences of single-use plastics. Their unfamiliarity with the long-term ecological impact of such items suggests a need for targeted educational interventions. As Diggle and Walker (2020) emphasize, education plays a pivotal role in fostering environmental awareness, particularly in encouraging youth to refuse single-use products. Strengthening curricular content and experiential learning opportunities related to sustainability can help bridge this gap and cultivate more responsible consumption habits among students.

These findings underscore the importance of continuous and developmentally appropriate environmental education throughout junior high school. As students progress through grade levels, their increasing awareness reflects the cumulative impact of school-based programs, peer influence, and exposure to environmental campaigns. Addressing the specific gaps, such as the refusal of single-use items, can further enhance the effectiveness of solid waste management initiatives within the school community.

A STEM-based approach offers a dynamic solution to address the observed gaps in awareness, particularly the limited understanding of refusing single-use items among Grade 7 and Grade 8 students. The STEM (Science, Technology, Engineering, and Mathematics) approach fosters critical thinking, problem-solving, and innovation, making it an ideal teaching strategy for enhancing environmental literacy and sustainable behavior among the youth.

Science integration in a STEM-based approach serves as a powerful platform for experiential learning to deepen the students' understanding of the environmental consequences of plastic waste. Through hands-on experiments and inquiry-based activities, students can explore the decomposition rates of various materials, compare biodegradable and non-biodegradable items, and analyze the chemical composition of plastics. These scientific investigations allow students to visualize and quantify the persistence of plastic waste in natural environments, fostering a more profound appreciation of its long-term impact on ecosystems and human health. As emphasized by Balubal et al. (2023), such integrative approaches in science education not only enhance awareness but also cultivate critical thinking and environmental responsibility among students.

Technology, on the other hand, offers innovative ways to enhance students' understanding of solid waste management. Tools such as mobile apps, simulations, and interactive games can help visualize waste accumulation and its environmental impact. Additionally, students can design digital campaigns or infographics to promote sustainable practices. By integrating technology, educators not only boost student engagement but also empower learners to become active advocates for environmental change in their communities (Diggle & Walker, 2020).

Furthermore, Project-based learning provides students with opportunities to apply engineering principles in addressing environmental challenges. By designing and prototyping eco-friendly alternatives to single-use items—such as reusable containers, compost bins, or localized recycling systems—students engage in hands-on problem-solving that fosters innovation and sustainability. These activities not only cultivate creativity but also reinforce the importance of sustainable design in everyday life. As Corporal et al. (2024) highlight, integrating engineering tasks into environmental education empowers learners to develop practical solutions that contribute to effective solid waste management.

Consistently, Mathematics plays a crucial role in helping students understand the quantitative aspects of solid waste management. By applying mathematical concepts, students can calculate the volume of waste generated within their school or community, monitor recycling rates, and model the potential reduction in waste through changes in behavior. These data-driven activities allow learners to present findings using graphs, charts, and statistical reports, thereby enhancing their analytical skills and environmental awareness. As noted by Madrigal and Oracion (2018), integrating mathematics into environmental education supports evidence-based decision-making and fosters a deeper understanding of the scale and urgency of waste-related issues.

By embedding STEM principles into environmental education, schools can transform abstract concepts into meaningful learning experiences. This approach not only improves awareness but also builds essential skills for sustainability, innovation, and leadership. As Diggle and Walker (2020) assert, education is the most essential factor in promoting

awareness and behavioral change among youth, especially in refusing single-use items. A STEM-based approach ensures that this education is both impactful and enduring. Also, STEM-based strategies align with the Department of Education's thrust toward 21st-century learning and sustainability. Learning comes not only informative but also transformative, equipping students with the tools to innovate, lead, and protect the environment.

This interdisciplinary method supports the development of critical thinking and advocacy skills, reinforcing the vital role of education in shaping responsible environmental stewards (Balubal et al., 2023; Corporal et al., 2024; Diggle & Walker, 2020; Madrigal & Oracion, 2018).

Sources of Acquiring Awareness on Solid Waste Management

Table 9: Sources of Awareness

STATEMENT I am aware toward solid waste management because of	Grade 7	Grade 8	Grade 9	Grade 10	WM	DR	RANK
1. Television or Radio	3.24	3.25	3.25	3.26	**3.25**	VGE	1
2. Research Articles	1.78	1.92	1.94	2.1	**1.9**	LGE	10
3. School's Orientation or Campaign	3.20	3.21	3.23	3.24	**3.22**	VGE	3
4. Books	2.1	2.3	2.5	2.8	**2.42**	LGE	5
5. Seminar Workshop	1.74	1.9	2.1	2.43	**2.04**	LGE	7
6. Teacher's Discussion	2.50	2.54	2.55	2.59	**2.55**	GE	4
7. Peers or Classmates	2.1	2.2	2.2	2.3	**2.2**	LGE	6
8. Newspapers or Magazines	1.81	1.87	2.2	2.2	**1.97**	LGE	9
9. Parents	1.83	1.86	2.1	2.2	**1.98**	LGE	8
10. Social Media (e.g. facebook, twitter)	3.21	3.25	3.25	3.28	**3.24**	GE	2

Table 9 shows the sources of awareness and how the respondents acquire awareness of solid waste management. The result shows that the listed sources are vital in raising solid waste management awareness. Among these, television or radio obtained the highest mean of 3.25 with a descriptive rating of very great extent. Thus, this finding denotes that television and radio have a great influence compared to other possible sources. This claim corroborates the findings of Dela Cruz (2020), stating that the usual use of radio or television affects the awareness of the public. Information obtained from the television or radio serves as a reliable source that is most trusted by the villagers in the community. Furthermore, despite the convergence of technologies and the birth of the internet, especially in the urban Philippines, internet penetration, literacy, and speed, particularly in the countryside, remain hindered by poor infrastructure (Pablo, 2018). For one, the poor internet speed makes it extremely difficult for individuals to easily access information, especially in rural areas (Gascon, 2020). Thus, television or radio is the most trusted and influential media in the access of reliable information, just like the essentials of practicing good management in solid waste.

On the other hand, social media, particularly Facebook or Twitter, ranks as the second source of awareness on solid waste management. This result is quite contrary to the first source of awareness, which is the television or radio. This is because social media technologies are rapidly becoming an important part of people's lives as the years go on.

People use social media to constantly communicate, read, comment, share, like, and create content (Chen and Sakamato, 2013; Ma et al., 2014). Similarly, millions of young people (Pempek et al. 2009), especially students, are the ones that heavily rely on these social networking sites (Edegoh et al., 2013) to obtain various information. There is a pervasive use of these new communication platforms, especially among young students.

In the study, social media ranks as the second source of awareness on solid waste management, since not all of the respondents have their own cellphones, especially, the grade 7 and 8 students. Another factor contributing to this cause is the issue on stable connections since many of them reside at an area where a stable connection is an issue. Thus, television or radio is the most available appliance through which they can access a piece of first-hand information.

Meanwhile, the school/community orientation and campaign rank third as the source of awareness since there is a constant program and policies on solid waste management. Dissemination and implementation of activities regarding solid waste and other related activities, just like clean-up drive are regularly conducted. Also, the school administration gives tasks and performances relating to solid waste management. The school campaign in practicing good management in solid waste plays a vital role in instilling the values and sustaining practices This statement conforms to the study of Orbe (2022), in which the school and the community are the empowering agents to reduce waste by practicing good discipline to oneself by merely throwing garbage in the right trash receptacles and promote the responsible used of items in school.

Teacher's discussions together with the books rank as the fourth and fifth source of awareness. Teachers are one of the vital factors to promote and influence good practice in managing solid waste. This statement is in consonance to the study of Harman (2020) stating that teachers serve as the driving agents to instill and constantly promote the right way of managing waste. In partnership with the books as the enriching resources to solidify the knowledge gained by the students during class sessions. This means that the extent of solid waste management is practiced by teachers in school and community. This further implies that the practices on solid waste management was frequently utilized in school. This further indicates that teachers practiced the waste management by showing as an example to their learners. The presence of school practices on waste reduction and waste separation was strongly implemented as part of the school program. Using positive environmental image and performance within teachers and community stakeholders can become enthusiastically involved and push for sustainable SWM practices.

Peers or classmates and seminar workshops place in the sixth and seventh rank as the sources of awareness among the Junior High School students. One vital reason is that the knowledge gained by the leading sources is then discussed and shared by the peers after internalizing and even emulating the said practices. Seminar workshops are least availed by majority of the students but for only the select representatives for distinct forums or seminars. But still, disseminating and imparting the knowledge from the resource speakers in the form of re-echoes is diligently conducted after each forum if necessary.

Parents rank as the eighth source of awareness on solid waste management among the respondents. This is notable and a sad reality knowing that parents are the ones responsible in forming good values toward solid waste management. The golden rule states that "Education starts at home", same goes at good practice should start at home. However, the result of the study is contrary to this statement. Most of the respondents are used to disposed waste at home without proper segregation. The parents are not empowering and instilling the value of proper waste disposal but just practicing constant cleaning without considering the essence of appropriate segregation This reality sadly justifies why parents rank as the bottom or least source of awareness regarding solid waste management. However, most of the studies on managing wastes pointed out that parents play a vital role in teaching kids about waste management at home. Teaching children at

home about the significance of and eco-friendly lifestyle and waste segregation is crucial (WHO, 2018). Because if you provide everything they need, they would think that resources are limitless. More so, that they deal on the usual habit done at home, and most importantly to what parents instill to them. In this scenario, the challenge is for the teachers to correct the misconception of waste management. Children require education on finite resources and how human activities affect the planet; otherwise, they will not be more conscientious about living on this planet (EPA, 2020).

Newspapers and magazines rank ninth as the respondents' source of awareness on solid waste management. News and information about the environment are least included in the newspapers and much more in the magazines. In the study, newspapers and magazines are not found in the reading corner of each classroom and so, the respondents have limited source of awareness using these materials.

Research articles rank as the last and the least source of awareness on solid waste management among the Junior high school students. This is because the school does not contain research articles on solid waste management. Thus, the respondents have no access to acquire knowledge of these resources.

Practices on Solid Waste Management

Waste management according to Nathanson (2023), refers to the collection, transport, recovery, and disposal of waste, including the supervision of such operations and after-care of disposal sites. It concerns itself with the existing amount of waste, trying to minimize the human-waste or environment-waste interface and to minimize potential impact. In this chapter, the respondents' practices on solid waste management are categorized as Segregation, Reduction, Reuse, Recycle, and Disposal of Wastes practices.

Table 10: Segregation of Solid Waste

STATEMENT **I practice solid waste management by**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
1. segregating waste based on/ which are								
a. Biodegradable (e.g. Papers, leaves, vegetable) from non-biodegradable (e.g. Plastics, wires, cans).	2.40	S	2.43	S	2.44	S	2.50	O
b. Recyclable (e.g. Papers, plastic bottles, cans) from non-recyclable (e.g. Food waste, leaves).	2.43	S	2.49	S	2.49	S	2.51	O
c. Non-harmful waste from toxic wastes (e.g. Battery, ink, pentel pen).	2.43	S	2.48	S	2.48	S	2.48	S
Composite Mean	**2.42**	**S**	**2.47**	**O**	**2.47**	**O**	**2.50**	**O**

Table 10 shows the practices of the Junior high school students in segregating wastes. Segregation as defined in Article 2, Sec. 3 of R.A. No. 9003, pertains to the process of separating materials from their origin to facilitate recycling, reuse of materials and reduce waste generation (Molina and Catan, 2021). From the table, most of the respondents practice waste segregation more often except for the grade 7 students who are practice segregation seldomly. But consistently, majority of them are segregating wastes properly. Thus, the overall rating further substantiates the overall result.

Table 11: Reduction of Solid Waste

STATEMENT **I practice solid waste management by**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
2. Reducing waste by								
a. Buying in bulk	2.44	S	2.45	S	2.47	S	2.48	S
b. Using ecobag	3.1	O	3.10	O	3.18	O	3.22	O
c. Using reusable items rather than single used items	2.58	O	3.12	O	3.15	O	3.23	O
d. Saying no to plastic if only have few items bought	2.53	O	2.58	O	2.59	O	3.1	O
e. Preferring items with less packing	2.54	O	2.59	O	3.0	O	3.25	A
f. Taking lunch in school using reusable container	3.38	A	3.43	A	3.45	A	3.47	A
g. Converting food waste into animal feed	3.12	O	3.17	O	3.20	A	3.21	O
h. Repairing broken furniture or appliances	1.65	N	1.68	N	1.71	N	1.71	N
i. Buying important items only	2.53	O	2.56	O	2.59	O	3.1	O
Composite Mean	**2.60**	**O**	**2.74**	**O**	**2.82**	**O**	**3.O**	**O**

Table 12: Reuse of Solid Waste

STATEMENT **I practice solid waste management by**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
3. reusing items such as								
a. scrap papers as scratch for solving	3.23	O	3.24	O	3.24	O	3.24	O
b. compostable waste is converted into fertilizer	2.40	S	2.42	S	2.44	S	2.45	S
c. washable food and water containers	3.33	A	3.37	A	3.39	A	3.45	A
d. grocery bags	2.1	S	2.23	S	2.34	S	2.46	S
e. intact and unused cloths and toys are given to the less fortunate.	1.36	N	1.47	N	1.63	N	1.69	N
Composite Mean	**2.21**	**S**	**2.55**	**O**	**2.61**	**O**	**2.66**	**O**

Table 13: Recycling of Solid Waste

STATEMENT **I practice solid waste management by**	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
	WM	DR	WM	DR	WM	DR	WM	DR
4. recycling of items by								
a. Converting old items into new products	2.3	S	2.51	O	2.53	O	3.1	O

b. Generating funds out from plastic bottles, metals or cans	2.50	O	2.57	O	3.1	O	3.21	O
c. Creating art craft	2.45	S	2.47	S	2.48	S	2.49	S
Composite Mean	**2.42**	**S**	**2.52**	**O**	**2.71**	**O**	**2.93**	**O**

Table 14: Disposal of Solid Waste

STATEMENT	**Grade 7**		**Grade 8**		**Grade 9**		**Grade 10**	
I practice solid waste management by	WM	DR	WM	DR	WM	DR	WM	DR
5. disposing								
a. Biodegradable items in compost pit	2.53	O	3.10	O	3.20	O	3.24	O
b. Items in proper trash bins	3.23	O	3.23	O	3.24	O	3.24	O
c. Waste materials in common open dumps	2.51	O	2.53	O	2.53	O	3.12	O
d. Non-biodegradable items by selling them at the junkshop	2.53	O	2.63	O	3.10	O	3.13	O
e. Special waste (e.g. laboratory waste) are disposed in a garbage container intended for a special waste	3.21	O	3.22	O	3.23	O	3.23	O
Composite Mean	**2.80**	**O**	**2.94**	**O**	**3.06**	**O**	**3.20**	**O**

Tables 11, 12, and 13 show the data on the 3R (reduce, reuse, and recycle) rule in solid waste management. As shown in the table, most of the respondents are more often practicing reduction, reusing, and recycling of wastes through buying items in bulk, using ecobag when purchasing items, not using plastic if only a few items are bought, and preferring items with less packing. This is one of the most effective methods implemented in waste management (Naria, Nasution & Santi, 2018). This rule comes to the fore in reducing waste, which has become a significant environmental problem (Aksan & Çelikler, 2019). In the integrated waste management system, following the approaches covered by the 3R rule, reducing wastes at the source, reusing, and recycling, then, incineration, and final disposal processes are carried out close to the waste source (Asteria & Haryanto, 2021). However, in the study, some of the respondents, specifically the grade 7 students, seldom practice the reuse and recycling activities, which denotes poor practice in solid waste management.

Furthermore, reusing waste for another purpose or in a different way is called reuse. People can reuse many materials, such as plastic bags, furniture, toys, etc., and repair some broken materials they use. They may also sell to others or give to charity. Additionally, recycling is when waste is reshaped and converted into raw materials that can create a new product (Dharmasiri, 2019). In this case, the grade 7 students have less capability of converting waste into a new product, and so this is a significant reason why they seldom settle on recycling raw materials. It is only true to those who can do this act. Thus, the study suggests boosting the students' understanding and skills in reusing as well as recycling.

Table 14 shows the practice of disposing of solid waste among the respondents. From the table, it can be noted that the respondents are practicing the proper disposal of waste more often. Each year level of the school has a designated compost pit located at the back of each classroom where the organic wastes are disposed. Also, each classroom is provided with three trash bins with non-biodegradable, biodegradable, and recyclable labels attached to each trash bin. Although the school does not enough Materials Recovery

Facility (MRF), since the dumping site is within the barangay where the school is situated, the disposal of waste is carried on following the designated day of collecting those wastes.

The results of the study highlight a critical gap between students' behavioral awareness and their legal and conceptual understanding of solid waste management. A STEM-based approach is necessary to bridge this gap by integrating scientific inquiry, technological innovation, and civic responsibility into environmental education. STEM lessons can contextualize laws like RA 9003 through real-world applications, such as waste audits, pollution analysis, and engineering challenges. Timbangan et al. (2025) demonstrated that contextualized STEM instruction significantly improves students' understanding of waste laws and practices. By embedding legal frameworks into science and technology activities, students can develop deeper knowledge, critical thinking skills, and a stronger sense of environmental stewardship.

Designing a Contextualized STEM Lesson

From the results of the study, designing a contextualized STEM lesson is proposed by crafting a prototype contextualized STEM product out of waste. This is the construction of an Eco bench that can be used for studying and a siesta during free time. This product serves as an application of STEM education and skills among Junior high school students. STEM stands for Science, Technology, Engineering, and Mathematics. STEM here is used as a learning strategy adhering to solid waste management. The strategy is carried through in which the group of students in each year level is divided into four groups. One group is assigned as the Science group, which will design the proposed prototype. Another group is the Technology, which is the charge of providing materials as well as the mechanics of the prototype. Another is the Engineering Group. The task of this group is to construct the designed prototype with the help of the other members. Lastly, the Mathematics group is assigned to calculate the cost of the prototype.

Realizing this activity could enable the whole population of the Junior high school students to be involved and engage in achieving the goal that is tangible and functional through the constant supervision of the assigned teacher. Also, collaboration from the teachers and administration, and the community is highly needed for its full implementation.

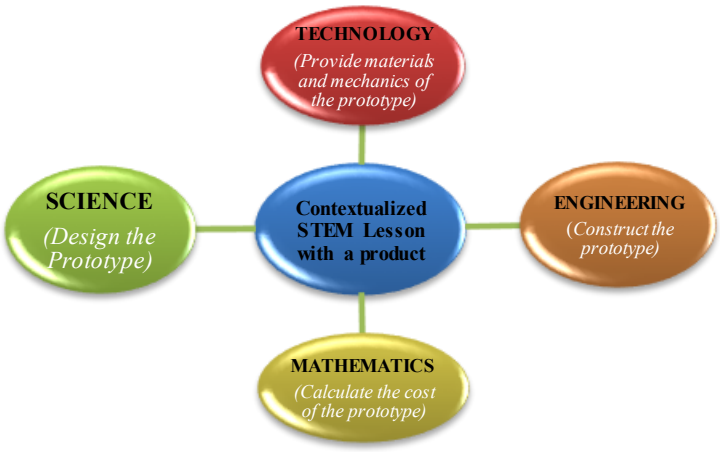

Figure 1. Diagram for conducting Contextualized STEM Lesson

4. Conclusion

The following statements concluded the study:

1. Respondents exhibit high awareness in identifying solid wastes and their roles and responsibilities in solid waste management, particularly in practices such as reducing waste, cleaning as you go (CLAYGO), segregating, composting, recycling, and reusing materials.
2. Awareness of refusing single-use items is notably limited among Grade 7 and Grade 8 students, indicating a gap in understanding the environmental impact of such products.
3. Respondents demonstrated high awareness that poor solid waste management can lead to adverse effects on human health, animal welfare, and the environment. They also showed understanding of prohibited waste-related activities, the importance of school-based interventions and initiatives, and their individual roles and responsibilities in promoting proper waste management practices. However, the data revealed a notable gap in their awareness of existing laws and ordinances governing solid waste management.
4. The study identified multiple sources contributing to students' awareness of solid waste management. These include mass media platforms such as television and radio, social media channels like Facebook and Twitter, and formal educational avenues, such as school orientations, campaigns, and classroom discussions led by the teachers. Additional sources include printed materials such as books, newspapers, and magazines, as well as informal influences from peers, parents, seminar workshops, and research articles. The diversity of these sources highlights the multifaceted nature of environmental education and underscores the importance of integrating both formal and informal channels to reinforce sustainable practices among the students.
5. Recycling remains less practiced due to limited exposure to creative reuse activities. While students understand the environmental and health impacts of poor waste management and recognize their roles in promoting sustainability, gaps persist in their awareness of legal frameworks and the refusal of single-use items, particularly among younger grade levels.

The overall findings of the study revealed that Junior High School students exhibit a high level of awareness and engagement in key solid waste management practices such as segregation, reduction, reuse, and proper disposal. However, recycling remains less practiced due to limited experience that would intensify and transfer their learning into a tangible and functional craft.

Awareness is shaped by a diverse range of sources, including media, school initiatives, peer influence, and family, underscoring the importance of both formal and informal education channels. The findings suggest a need for targeted interventions, especially those that integrate STEM-based strategies and community involvement, to enhance students' practical skills, legal literacy, and creative engagement in sustainable waste management.

5. Recommendations

From the study, the following inputs were recommended:

1. Integrate solid waste management topics more deeply into the curriculum, especially for younger students (Grades 7 and 8), to address gaps in understanding the environmental impact of single-use items and the importance of sustainable consumption.
2. Include discussions and activities related to Republic Act 9003 (Ecological Solid Waste Management Act of 2000) and other local ordinances in classroom instruction to improve students' legal awareness and compliance.

3. Use interdisciplinary STEM strategies, such as scientific experiments, digital tools, engineering design challenges, and mathematical modeling, to make waste management concepts more engaging, practical, and impactful.
4. Encourage students to repurpose recyclable materials into crafts or functional items through art-integrated lessons, school competitions, and project-based learning to increase recycling participation through a STEM-based approach.
5. Teachers and administrators may organize seminars, workshops, and awareness drives that focus on both practical waste management and the legal framework. These should be interactive and age-appropriate to ensure retention and application.
6. Build a school-based environmental organization and empower students to lead sustainability initiatives within the school, such as monitoring waste segregation, organizing clean-up drives, and advocating for plastic-free practices.
7. Future researchers are encouraged to include parents and community members as respondents to better assess their awareness and practices in solid waste management. This broader perspective can help inform targeted interventions for students.

6. Acknowledgments

The researcher extends her profound gratitude to Dr. Monera Salic-Hairulla, the teacher of this course, for the brilliant inputs and teachings inculcated in the class. Also for her constant motivation and guidance extended for the realization of this study;

To the participants for their utmost and distinct participation in the collection of data;

Above all, to God Almighty for the strength, wisdom and knowledge bestowed to the researcher. The success of the study is not possible without His abundant and sufficient grace spared every single moment. Thank you, Lord for everything. All the glory and honor belong to Jesus Christ forever!

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Appendix

Contextualized STEM Lesson on Solid Waste Management regarding Sutaphan and Yuenyong (2019) STEM education pedagogical framework

Lea E. Salon

Objectives:

At the end of the lesson, the students are expected to:

1. Discuss the overall concept of Solid Waste Management and its impact to the environment;
2. Craft a contextualized STEM product that is functional for the whole school community; and
3. Construct a STEM product as an application of a contextualized STEM lesson on solid waste management.

STAGE	ACTIVITY
1. Identification of Social Issues	Introduction: Claveria, Misamis Oriental is a first-class municipality in the Province of Misamis Oriental. According to the 2020 census, it has a population of 52,478 people. It is the only landlocked municipality of Misamis Oriental. It is also the largest in terms of land area in the province. The municipality has Ecological Solid waste management plan approved by the Department of Natural Resources. However, several issues in solid waste management still surfaced. These issues include improper, waste segregation practices, a delayed schedule of collecting garbage, and no enough facilities to foster proper disposal of wastes. This STEM lesson tries to minimize these issues by crafting a product out of waste that is functional and beneficial to the whole populace of Rizal National High School.
2. Identification of Potential Solutions	Procedures: 1. The science group will design in craft a product to which a solid waste management practice is adhered. 2. The math group will calculate the cost of the needed materials for a crafted product. 3. The Engineering and Technology group will decide on the needed materials for the product.

3. Need for Knowledge	• The teacher will discuss on the concepts of the lesson on solid waste management • The teacher will show a video on the impacts of the environment of solid waste management. Also, a video on how to construct an eco-bench • Discuss the possible precautions and the things to consider in crafting the product
4. Decision-making	• Make a list of possible solutions to the identified social problem • Select the best possible solution to the issue considering the following STEM's capitals -physical, financial, social, human and natural aspects • Decide on the output and make a general consensus in constructing the product • Each group (year level) will design a blueprint on steps of constructing the product using the assigned task.
5. Development of Prototype or Product	The teacher will give the rubric as a basis of evaluating a crafted product/solution to the issue. Develop a prototype or product based on the chosen solution. Example: Steps on how to Construct an Eco-Bench Materials: Used Plastic bottle Sticks/spoons/similar tools for compacting the waste Procedures/Steps: 1. Gather Your Materials: You'll need an empty plastic 2. bottle, a long stick (like a wooden spoon), and a decent 3. pair of kitchen scissors. 4. Collect Your Plastic: Gather your single-use plastic 5. waste. This can include plastic bags, wrappers, 6. packaging, etc. Make sure all the plastic is clean and dry to prevent bacterial growth. 7. Prepare Your Plastic: Cut your collected plastic into small pieces using your scissors. A smaller size helps you pack the plastic more tightly into the bottle. 8. Start Filling: Feed the small pieces of plastic into the bottle. If the opening of your bottle is small, you might find it helpful to use a funnel or make one from a rolled-up piece of paper. 9. Compact Your Plastic: Every so often, use your stick to push and compact the plastic down into the bottle. This step is crucial, as the density of the eco-bench is what gives it its strength and usability. 10. Keep Going: Continue the process of adding plastic and compacting it until your bottle is filled to the brim. 11. Final Compact: When your bottle is full, give it one last compacting push with your stick. The completed bench should be solid and hard enough for you to sit on. Divisions of the Product: **Science:** concept and design **Technology:** provide the materials needed **Engineering:** construct the product **Mathematics**: cost of the product and measurement of each material
6. Test and evaluation of solution	• The teacher and the school administration will evaluate the product by letting some students to sit down on the product (eco-bench). • The usability depends on how the product was made.

7. Socialization and completion decision stage	• Ask the assistance from the local officials to facilitate the product 1. Name of prototype or product 2. Materials used 3. Procedures in crafting the prototype or product 4. Results of the evaluation of prototype or product

RUBRIC IN ASSESSING AND EVALUATING THE PRODUCT (ECO-BENCH)

Criteria	Excellent (4)	Very good (3)	Good (2)	Needs improvement (1)	Points
• **DURABILITY**					
a. Quality	Very useful and highly necessary	Useful and necessary	useful but unnecessary	Not useful and unnecessary	
b. Appearance	The over-all appearance of the prototype is exemplary	The over-all appearance is not good to look at	The over-all appearance of the prototype is dull	The over-all appearance of the prototype is messy and untidy	
• **ORIGINALITY**					
b. Design	Very unique and authentic	Unique and authentic	Authentic but not unique	Not authentic and not unique	
c. Texture	Very Smooth with no glasses and breakable materials	Smooth but tattered materials are visible in the product	Slightly smooth and some plastic materials are not cut and placed	Rough with many tattered plastic materials that are not properly cut and placed	
• **USABILITY**					
a. Safety in using the product	Hard compacted plastic materials with firmness which is able to carry anybody who sits on	Hard compacted plastic materials with firmness able to sustain its safety to sit on	Soft bounded and compacted plastic materials which is not safety to sit on	Not safety to use with which tattered and glass are included in the product	
				TOTAL POINTS	