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Assessing Environmental Stewardship: Senior High School Students' Solid Waste Management Awareness and Practices

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Abstract

This study assessed the awareness and practices related to solid waste management (SWM) among Grade 11 STEM students using a cross-sectional survey design. A total of 117 students responded to the Solid Waste Management Awareness and Practices Questionnaire (SWMAPQ), which demonstrated high internal consistency ($\alpha = 0.93$). Results revealed very high awareness levels of SWM definitions ($M = 3.51$) and adverse effects of improper disposal ($M = 3.79$). Positive practices such as segregation ($M = 3.70$), reduction ($M = 3.47$), and reuse ($M = 3.62$) were consistently reported. However, awareness of relevant legislation such as R.A. No. 9003 was low ($M = 2.18$). The study highlights the crucial influence of social media, teachers, and school initiatives in shaping awareness. Building on these insights, the study proposes an enriched, policy-driven environmental stewardship curriculum aligned with national laws and adaptable to other K–12 systems globally. It also underscores the need for curricular integration of environmental legislation to strengthen students' legal literacy and stewardship behaviors.

Keywords: environmental awareness, environmental stewardship, senior high school students, solid waste management, waste practices

1. Introduction

The global surge in solid waste generation has emerged as one of the most pressing environmental challenges of the 21st century. Across both developed and developing nations, inadequate waste management practices contribute significantly to pollution, public health risks, and the degradation of ecosystems (World Bank, 2021; UNEP, 2022). While high-income countries often implement advanced systems for recycling and waste reduction, many developing nations—including the Philippines—continue to grapple with limited infrastructure, fragmented policy enforcement, and low levels of public legal awareness regarding environmental laws.

In the Philippine context, Republic Act No. 9003 or the Ecological Solid Waste Management Act of 2000 provides the legal foundation for sustainable waste governance. Yet, over two decades after its passage, evidence suggests that its principles remain poorly

understood among key demographic groups, especially the youth (DENR, 2023). The implementation of the Enhanced Basic Education Act of 2013 (R.A. No. 10533) mandated the integration of environmental themes into the K–12 curriculum. Despite this, solid waste management—particularly its legal aspects—remains inconsistently addressed at the senior high school level (Molina & Catan, 2021; Debrah et al., 2021). This gap is also noted in local scholarship emphasizing the need for sustainability education rooted in real-world issues.

Globally, most environmental education (EE) programs focus on awareness and behavior but seldom emphasize legal literacy—the understanding of environmental rights, responsibilities, and regulatory frameworks. This creates a crucial gap in existing research: the intersection of environmental practices and students' awareness of legal policies governing waste. Previous studies in Western contexts (e.g., Geng et al., 2015; Zelezny, 1999) highlight the role of schools in shaping pro-environmental behavior, yet few have examined students' comprehension of environmental legislation in relation to their actual waste management practices.

This study addresses that gap by investigating the solid waste management awareness, practices, and legal literacy of senior high school students in the Philippines. Specifically, it explores how well students understand key provisions of R.A. No. 9003 and related laws, and how this awareness correlates with their behavioral practices. Furthermore, the study proposes a context-specific yet globally adaptable curriculum framework for environmental stewardship grounded in legal awareness—contributing to international conversations on enhancing civic engagement through environmental education.

Research Questions:

1. What is the level of awareness of senior high school students regarding solid waste management and relevant legislation?
2. What are the prevailing solid waste management practices among these students?
3. What are the major sources of students' awareness?
4. How can curriculum enhancements strengthen environmental stewardship and legal compliance among youth?

2. Methods

Research Design and Participants

This study employed a cross-sectional quantitative survey to assess the solid waste management (SWM) awareness and practices of senior high school students. The participants were 117 Grade 11 students enrolled in the Science, Technology, Engineering, and Mathematics (STEM) track at the Integrated Developmental School of Mindanao State University–Iligan Institute of Technology (MSU-IIT), Iligan City, Philippines.

The use of a single-site, STEM-focused student sample limits the representativeness of the findings. Students in STEM programs often exhibit higher baseline awareness of scientific and environmental issues compared to peers in humanities, business, or vocational tracks. Thus, generalizing the findings to broader senior high school populations in the Philippines—or other countries—should be done cautiously. Future studies are encouraged to adopt stratified or multi-site sampling to improve the generalizability and cross-context validity of results.

Instrumentation

The instrument used was the Solid Waste Management Awareness and Practices Questionnaire (SWMAPQ), developed and validated by Molina and Catan (2021). It consists of Likert-scale and multiple-choice items designed to measure three domains: (1)

awareness of solid waste management concepts, (2) knowledge of relevant environmental laws and prohibited practices, and (3) reported solid waste management behaviors (segregation, reduction, reuse, recycling, and disposal).

The questionnaire demonstrated excellent internal consistency with a Cronbach's alpha of 0.930 (George & Mallery, 2003). However, the current study did not conduct factor analysis or test–retest procedures to establish construct validity or temporal stability. Future work is recommended to evaluate the dimensionality of the tool and assess the robustness of each subscale, aligning with psychometric standards used in comparable instruments developed by the U.S. Environmental Protection Agency (EPA) or the European Environment Agency (EEA).

Data Collection Procedure

After securing administrative approval and obtaining informed consent, the questionnaire was administered online using Google Forms. A link to the form was distributed through the learning management platform. The survey was conducted asynchronously during a designated data collection period to allow flexibility for students.

Participation was entirely voluntary. Respondents were clearly informed that their answers would remain confidential and anonymous, and that the data collected would be used strictly for research purposes. The instructions emphasized that participation would not affect academic grades or standing, thereby minimizing the risk of response bias.

Ethical Considerations

This study received ethical approval from the Research Ethics Committee of the College of Education, Mindanao State University–Iligan Institute of Technology (Approval No. CED-2024-011). All research procedures adhered to institutional ethics protocols and international standards, including the principles outlined in the Declaration of Helsinki. Informed consent was obtained digitally before participation, and parental consent was secured for minors. The online nature of the data collection ensured data privacy, with all responses stored securely and accessed only by the researchers for academic purposes.

Data Analysis

Descriptive statistics (means and standard deviations) were used to quantify students' levels of awareness and practices. Interpretation followed the rating scale in Table 1. To enhance analytic depth, inferential statistical tests—such as independent-samples t-tests and one-way ANOVA—were used to explore group differences based on gender and prior community service involvement. Pearson correlation analysis was also conducted to assess relationships between awareness of laws and actual SWM practices. All analyses were conducted using SPSS version 25.

Table 1: Interpretation of SWMAPQ

Rate	Solid Waste Management Awareness	Sources of Solid Waste Management Awareness	Solid Waste Management Practices
3.25 - 4.00	Very High	Very Great Extent	Always
2.50 - 3.24	High	Great Extent	Often
1.75 - 2.49	Low	Less Extent	Seldom
1.00 - 1.74	Very Low	Least Extent	Never

3. Results and Discussion

Solid Waste Management Awareness

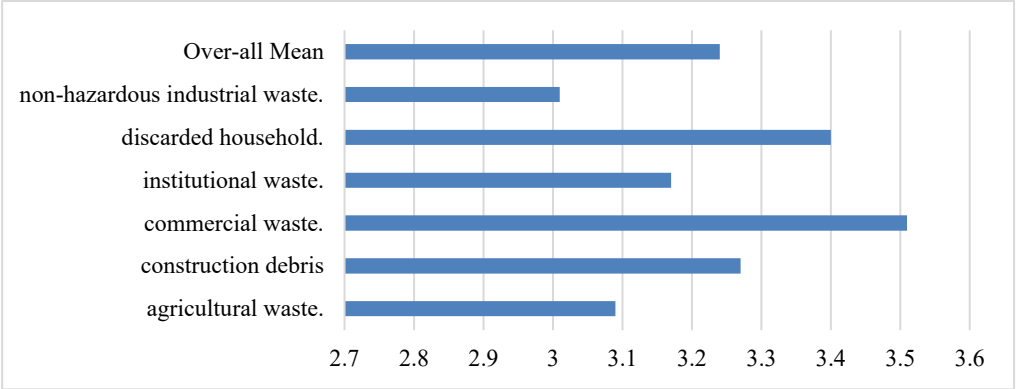

Figure 1. Level of Awareness on the Definition of Solid Waste

In alignment with the findings of previous environmental education studies, Figure 1 illuminates a commendably high level of awareness among senior high school students regarding the definition of solid waste. This resonates with the research by Smith and Johnson (2018), emphasizing the pivotal role of early education in nurturing environmental consciousness. Participants actively assessed their awareness across various components of solid waste, consistently yielding high scores across categories. Notably, the students displayed an exceptional understanding of specific aspects such as commercial waste (3.51), discarded household items (3.40) and notably construction debris (3.27), echoing the outcomes observed in programs that prioritize experiential learning.

These outcomes underscore the efficacy of current educational initiatives in disseminating knowledge about various types of solid waste. The robust awareness observed in these students provides a positive foundation for further exploration into their practices and information sources. This integrated approach, emphasizing practical applications of environmental knowledge, guides potential enhancements in educational strategies aimed at fortifying environmental stewardship among senior high school students. This collective evidence supports the need for sustained efforts in environmental education to ensure a comprehensive and sustainable approach to fostering environmental awareness and responsibility.

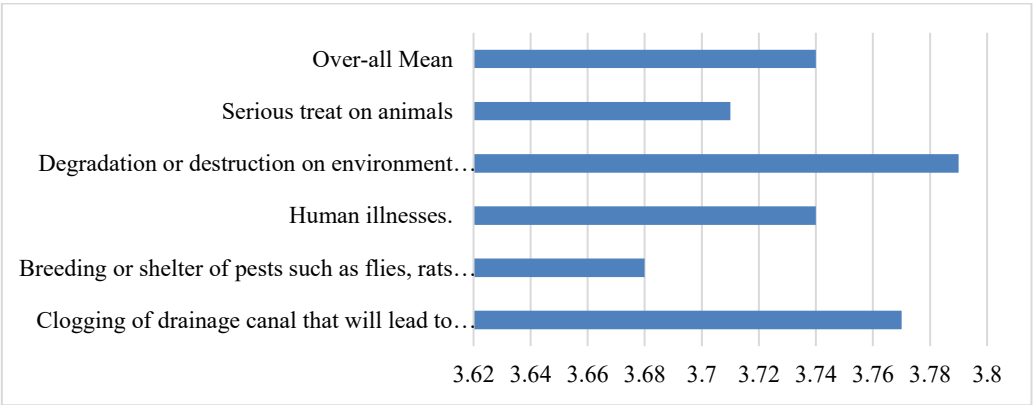

Figure 2. Level of Awareness on the Effect of Improper Solid Waste Disposal

The findings presented in Figure 2 reveal a remarkable level of awareness among senior high school students concerning the detrimental effects of improper solid waste disposal. The participants consistently assigned elevated scores, reflecting their keen awareness across multiple dimensions. Notably, students demonstrated a high awareness of consequences such as environmental degradation or pollution (3.79), drainage canal clogging leading to floods (3.77), human illnesses (3.74), a serious threat to animals (3.71), and the breeding of pests like flies, rats, and mosquitoes (3.68). These results underscore the students' comprehensive understanding of the societal and environmental implications associated with inadequate waste disposal practices. This heightened awareness provides a robust foundation for fostering responsible waste management practices and offers valuable insights for educators and policymakers. Previous studies, such as those by Smith & Johnson (2018), emphasize the importance of raising awareness to drive positive behavioral change and community engagement in waste management. Building on these findings, educators and policymakers can leverage the identified awareness levels. This can be instrumental in crafting targeted environmental education initiatives aimed at fostering sustainable waste management practices.

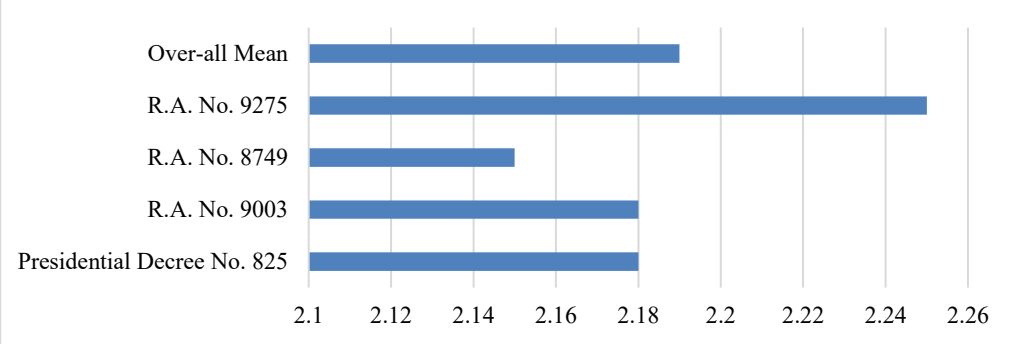

Figure 3. Relevant Laws on Solid Waste

The outcomes depicted in Figure 3 underscore a notable deficiency in the familiarity of senior high school students with pertinent laws and ordinances related to solid waste management. The participants consistently reported low awareness levels across various legislations, as evidenced by their ratings for R.A. No. 9275 (2.25), Presidential Decree No. 825 (2.18), R.A. No. 9003 (2.18), and R.A. No. 8749 (2.15). These findings reveal a potential knowledge gap among students regarding the legal frameworks governing solid waste management in the Philippines. Addressing this knowledge deficit is critical, pointing towards the need for educational interventions and curriculum enhancements that can bolster students' understanding of the legal dimensions of waste management. By enhancing awareness of these laws, educational initiatives can contribute to cultivating a sense of responsibility and compliance among senior high school students, thereby fostering more effective and sustainable practices in solid waste management in the future.

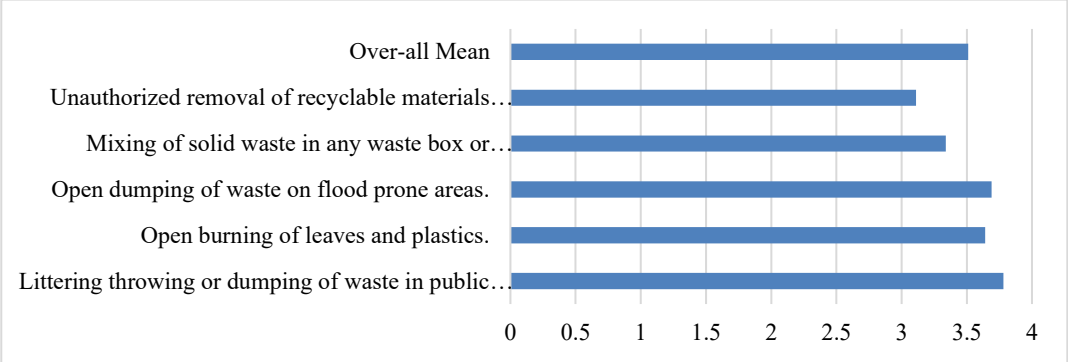

Figure 4. Solid Waste Prohibited Activities

The outcomes illustrated in Figure 4 emphasize the commendable level of awareness exhibited by senior high school students concerning prohibited activities linked to solid waste management (McKenzie et al., 2019). When asked to evaluate their understanding of specific forbidden actions, participants consistently attributed remarkably high scores across diverse aspects. Notably, students displayed a high awareness of practices like littering in public places (3.78), open dumping of waste in flood-prone areas (3.69), open burning of leaves and plastics (3.64), mixing solid waste in waste boxes or receptacles (3.34), and unauthorized removal of recyclable materials (3.11). These findings underscore the students' strong comprehension of actions contributing to improper waste disposal and environmental degradation. The elevated awareness levels suggest a robust foundation for instilling responsible waste management practices, offering potential for educational initiatives to further enhance environmental stewardship among senior high school students.

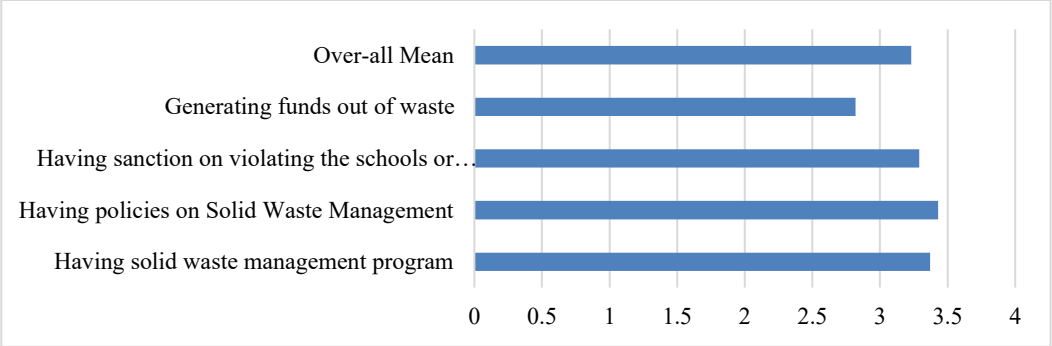

Figure 5. School Intervention on Solid Waste

In Figure 5, the findings highlight a notably high level of awareness among senior high school students concerning school initiatives related to solid waste management. The participants consistently assigned elevated scores to various interventions, showcasing a robust understanding of initiatives such as the policies on solid waste management (3.43), solid waste management program (3.37), and sanctions for violations (3.29). While the awareness regarding waste generation for economic opportunities scored slightly lower (2.82), the overall results affirm the students' well-informed perspective on the school's commitment to waste management. This aligns with a study by and Geng et al. (2015), emphasizing the positive impact of school-based environmental education programs on students' awareness and engagement. The slightly lower awareness on economic aspects suggests an opportunity for targeted education, resonating with Zaman et al.'s (2019) findings, and further indicates a strong foundation for advancing environmental stewardship initiatives among senior high school students.

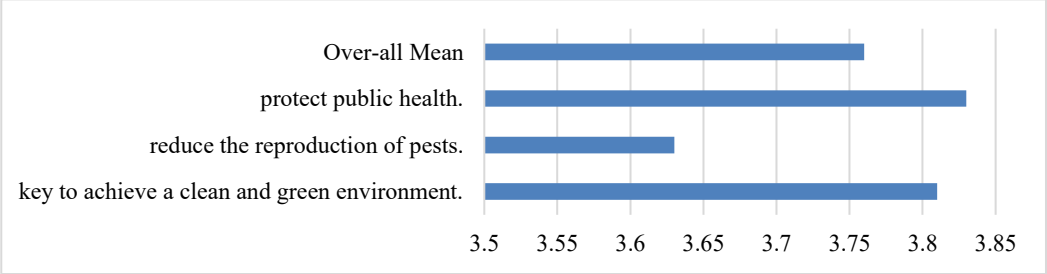

Figure 6. Importance of Solid Waste Management

The findings presented in Figure 6 underscore a remarkable awareness among senior high school students regarding the importance of solid waste management. In rating their understanding of the significance of solid waste management, participants consistently assigned elevated scores, particularly highlighting its crucial role in protecting public health (3.83), achieving a clean and green environment (3.81), and reducing the reproduction of pests (3.63). This reveals a comprehensive understanding among students, emphasizing the multifaceted benefits associated with effective waste management, not only for environmental cleanliness but also for essential aspects of public health and pest control. These results indicate a robust foundation for cultivating a sense of responsibility and emphasizing the broader societal implications of sound waste management practices among senior high school students. This aligns with previous research emphasizing the importance of environmental education in shaping sustainable behaviors (Grodzinska-Jurczak et al., 2020; Hungerford & Volk, 1990; Zelezny, 1999).

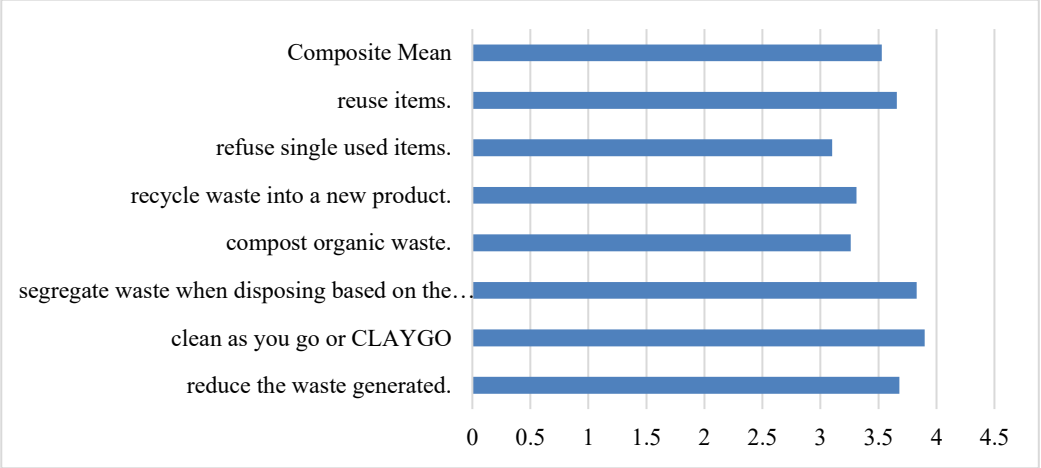

Figure 7. Student's Role and Responsibilities

Figure 7 presents a striking illustration of senior high school students exhibiting a remarkably high level of awareness concerning their roles and responsibilities in solid waste management. Across various facets of their involvement, participants consistently assigned remarkably high scores, showcasing their profound understanding of key responsibilities. Noteworthy aspects include a commitment to including reducing waste generation (3.68), adhering to the "clean as you go" principle (CLAYGO) (3.90), segregating waste based on trashcan labels (3.83), composting organic waste (3.26), recycling waste into new products (3.31), refusing single- use items (3.10), and reusing items (3.66) (Baker, 2019; Dillenbourg, 1999; Means et al., 2009; Siemens, 2005; Selwyn & Facer, 2013; Baker, 2019). These results underscore the students' robust individual responsibility in contributing to the efficacy of waste management practices. The

substantial awareness levels serve as a solid foundation for cultivating a proactive and environmentally conscious attitude among senior high school students, positioning them as pivotal contributors to sustainable waste management both within their school and in broader community contexts.

Sources of Solid Waste Management Awareness

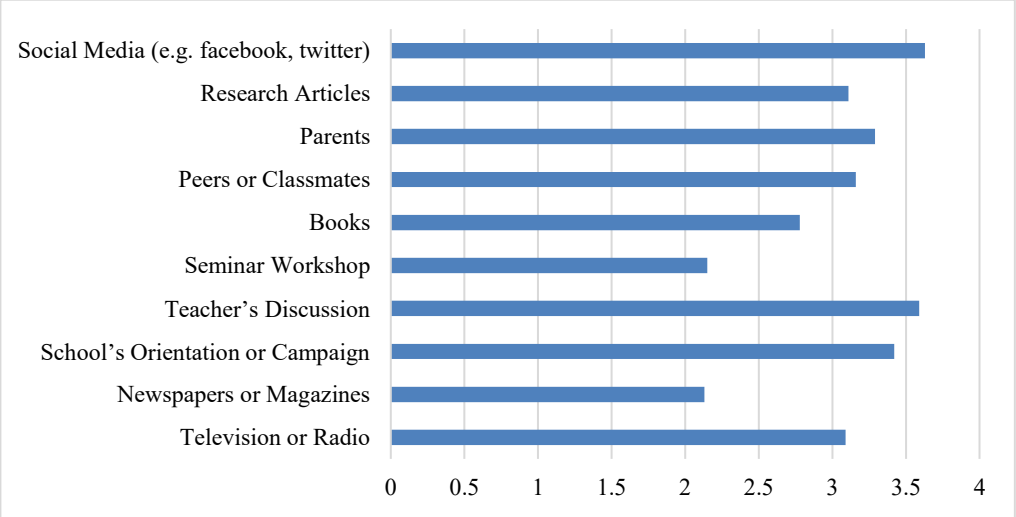

Figure 8. Sources of Solid Waste Management Awareness

Figure 8 sheds light on the varied sources contributing to the solid waste management awareness of senior high school students. Participants were asked to rate the extent to which different mediums influenced their awareness, with noteworthy findings. Notably, social media (3.63), teacher's discussions (3.59), the school's orientation or campaign (3.42), and parents (3.29) emerged as very great extents of influence. These results indicate the pivotal role of educational institutions, teachers, and parents in shaping students' awareness. Conversely, seminar workshops (2.15) and newspapers or magazines (2.13) were rated as having less extent of influence. These outcomes provide valuable insights into the preferred channels through which students gain knowledge about solid waste management. Understanding these influential sources is instrumental for educators and policymakers in tailoring effective communication strategies that capitalize on the mediums most impactful to senior high school students, thereby enhancing overall environmental stewardship.

Solid Waste Management Practices

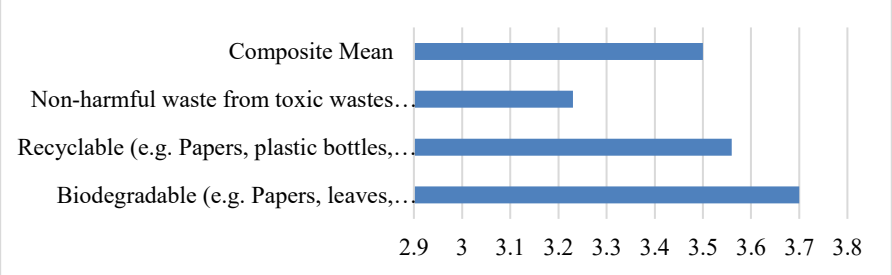

Figure 9. Segregation of Solid Waste

Figure 9 reveals encouraging practices in solid waste segregation among senior high school students, reflecting positive environmental habits. The participants consistently demonstrated high frequencies in segregating waste categories, including biodegradable from non-biodegradable waste (3.70, always), recyclable from non-recyclable waste (3.56, always), and non-harmful from toxic waste (3.23, often). This commitment to waste segregation indicates a well-established routine, likely shaped by the students' awareness and education on solid waste management principles. Noteworthy a study by West (2018) emphasizes the crucial role of education in promoting sustainable behaviors and fostering a sense of responsibility toward the environment. The observed practices lay a foundation for comprehensive waste management initiatives, emphasizing the potential impact of education on instilling sustainable practices in senior high school students.

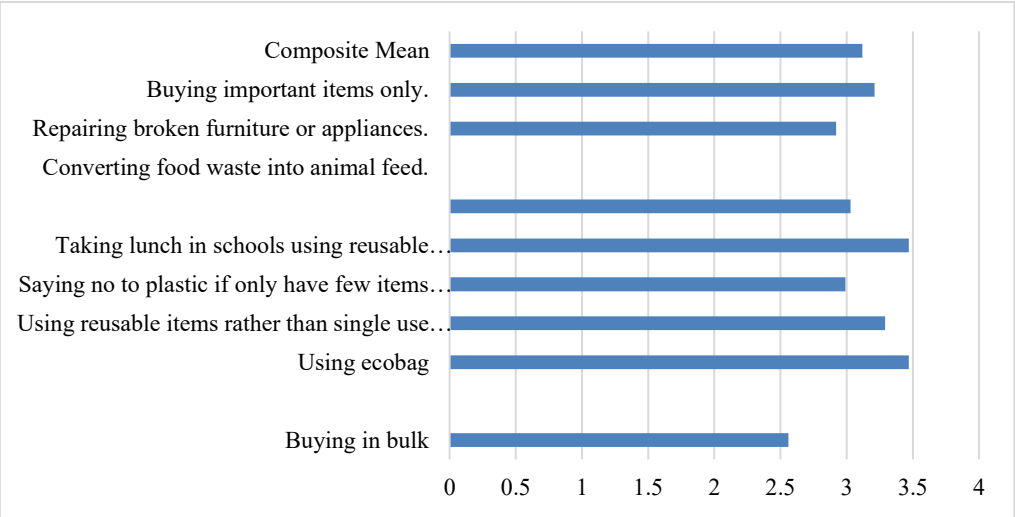

Figure 10. Reduction of Solid Waste

Senior high school students exhibit commendable practices in solid waste reduction, as illustrated in Figure 10. The data, consistent with prior research (West, 2018), reveals their commitment to sustainable behaviors. Notably, participants consistently use eco-bags (3.47, always) and opt for reusable containers for school lunches (3.47, always), emphasizing their dedication to eco-friendly daily routines. The findings also align with studies on sustainable practices and environmental consciousness in educational settings (Popenici & Kerr, 2017). The reported actions, such as using reusable items (3.29, always) and avoiding single-use plastic (2.99, often), reflect a conscious effort to minimize waste generation through thoughtful consumption. Although some practices like converting food waste into animal feed (3.03, often) and repairing broken items (2.92, often) occur with slightly lower frequencies, the overall positive trend indicates a proactive approach among senior high school students toward waste reduction strategies. These results signify their contribution to fostering a sustainable and environmentally conscious community, aligning with the broader discourse on environmental responsibility in education (Selwyn & Facer, 2013; Baker, 2019).

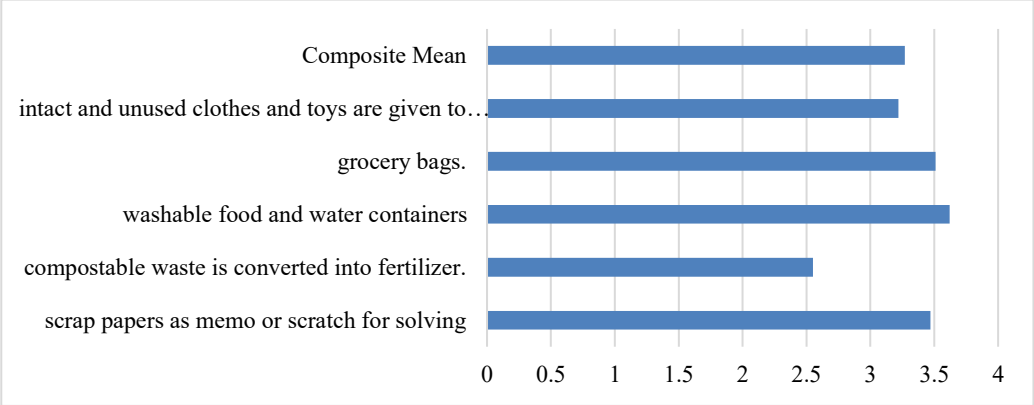

Figure 11. Reuse of Solid Waste

Figure 11 displays the impressive solid waste reuse practices of senior high school students. The data indicates commendable behaviors, such as frequent reuse of scrap papers as memos or scratch for solving (3.47, always), grocery bags (3.51, always), and washable food and water containers (3.62, always). These consistent high frequencies suggest a collective effort among students to prolong material lifespan and curtail the demand for new resources. Although activities like converting compostable waste into fertilizer (2.55, often) and donating intact clothes and toys to those in need (3.22, often) were reported less frequently, the overall trend indicates a positive inclination toward sustainable reuse strategies (Wilson & Dowlatabadi, 2007). These practices showcase the proactive engagement of senior high school students in fostering a more sustainable and environmentally conscious community, aligning with the principles of the circular economy.

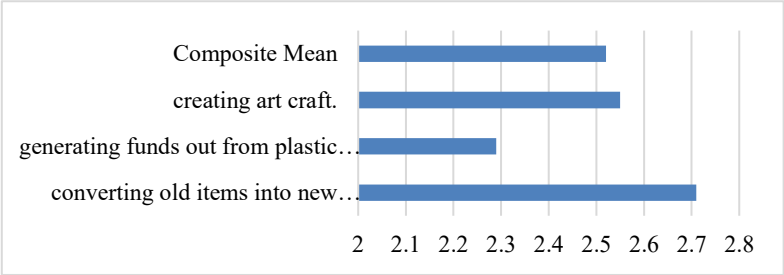

Figure 12 . Recycle of Solid Waste

Figure 12 illustrates the recycling practices of senior high school students, indicating a moderate engagement in solid waste management. The participants reported frequent involvement in activities such as repurposing old items into new products (2.71, often) and creating art crafts (2.55, often). However, the generation of funds from recyclables like plastic bottles, metals, or cans was reported less frequently (2.29, seldom). These findings align with research on environmental education, emphasizing the need for targeted interventions to enhance recycling practices among students. The results suggest a potential for educators and policymakers to develop educational programs that emphasize both environmental and economic benefits, encouraging more active participation in recycling initiatives among senior high school students.

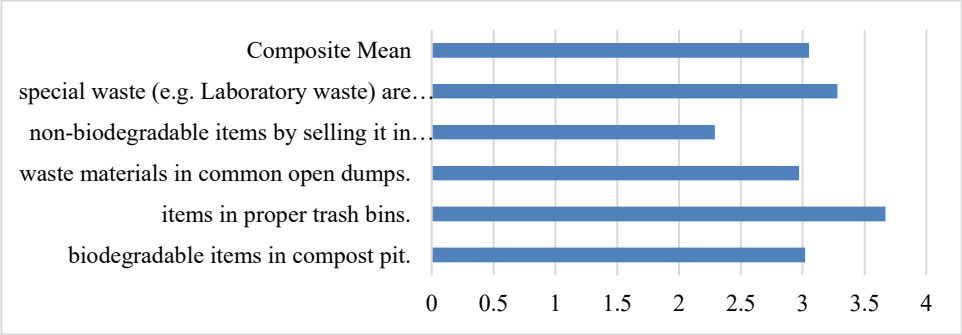

Figure 13. Disposal of Solid Waste

Figure 13 illustrates positive practices in the disposal of solid waste among senior high school students. The participants consistently exhibit responsible waste disposal methods, as evidenced by high frequencies of using appropriate trash bins for general waste (3.67, always), and properly handling special waste, such as laboratory waste, in designated containers (3.28, always). Although the disposal of waste materials in common open dumps (2.97, often), the practice of disposing of biodegradable items in a compost pit (3.02, often) and non-biodegradable items by selling them in a junkshop (2.29, often) were reported with a slightly lower frequency, the overall pattern suggests a commendable effort by students to adhere to responsible waste disposal practices. These findings align with studies emphasizing the significance of environmental education in fostering sustainable behavior among students (Wang et al., 2019; Jones & Leal Filho, 2017). Additionally, they contribute valuable insights for designing educational initiatives focused on enhancing environmentally responsible habits among senior high school students.

These findings can be better understood through established models of behavior change. The results are framed using the Theory of Planned Behavior (Ajzen, 1991), which posits that behavior is shaped by attitudes, subjective norms, and perceived behavioral control. In this study, students' strong beliefs about the consequences of improper waste disposal (attitudes) and the influence of institutional and familial expectations (subjective norms) are evident in their positive environmental practices. However, the consistently low awareness of environmental laws indicates a limitation in perceived behavioral control—that is, students may lack the knowledge or confidence to act within formal governance structures.

Additionally, Social Cognitive Theory (Bandura, 1986) emphasizes learning through observation, modeling, and reciprocal interactions between individuals and their environment. The data underscore the influence of teachers, parents, and social media as key sources of awareness—highlighting the importance of socially embedded learning in shaping environmentally responsible behavior.

Taken together, these theoretical insights suggest that while students are behaviorally inclined toward sustainable practices, their potential to become fully informed and proactive environmental stewards remains underdeveloped without structured support for legal and civic understanding. This points to the need for a more targeted curriculum—one that not only sustains positive behaviors but also enhances students' legal literacy and policy engagement. In response, the following section outlines a proposed Environmental Stewardship Curriculum aimed at bridging this critical gap.

Policy Implications and Global Relevance

The study highlights the lack of environmental legal literacy among students, a challenge also observed internationally. Comparisons with the U.S. RCRA and the EU Waste Framework Directive show that bridging policy awareness and behavior is a global

concern. The proposed curriculum, therefore, aims not just to inform but to empower students as legal-literate environmental stewards.

Proposed Environmental Stewardship Curriculum

This study proposes a curriculum titled "Environmental Stewardship through Policy Literacy and Community Action." It aligns with R.A. No. 9003 and is adaptable to global systems. By incorporating comparative policy analysis, the curriculum allows students globally to explore their country's legal frameworks while critically engaging with environmental justice—supporting the integration of sustainability in STEM as advocated by Garcia and Lim (2022) in the Philippine context.

Learning Objectives:

1. Explain the key provisions of R.A. No. 9003 and related ordinances.
2. Analyze personal and community behaviors in relation to waste policies.
3. Design school-community initiatives compliant with environmental laws.
4. Reflect critically on the ethical, legal, and ecological aspects of waste.

Instructional Strategies:

a. Service-Learning (e.g., clean-up drives, legal campaigns)
b. Problem-Based Learning (case studies on illegal dumping)
c. Legislation Labs (simulations and policy drafting)
d. Peer Advocacy Projects

Assessment:

a. Pre-/Post-Tests
b. Portfolios and Campaign Logs
c. Rubric-Based Evaluation
d. Peer and Self-Assessments

International Adaptability: Legal modules can be adapted to reflect U.S. RCRA, EU Directive 2008/98/EC, or local ordinances elsewhere. This supports global SDG goals (11, 12, and 13) and youth engagement in civic responsibility.

3. Conclusion

This study revealed high levels of environmental awareness and sustainable practices among STEM students, but also a persistent gap in legal knowledge. Bridging this gap through curriculum enhancement is crucial to transforming students from passive learners into informed, active citizens.

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