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From Attitude to Action: Knowledge as a Mediating Factor Between Attitude and Solid Waste Management Practices Among College Students

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Abstract— *Solid waste management (SWM) is vital for environmental sustainability. This study examined college students' knowledge, attitudes, and practices (KAP) regarding SWM and the mediating role of knowledge in the relationship between attitude and practice. A total of 370 students from a higher education institution in Ozamiz City, Misamis Occidental, were surveyed using validated Likert-scale questionnaires. Data were analyzed through descriptive statistics, correlation, multiple regression, and mediation analysis. Results showed that students had very high knowledge ($M = 4.60$), very good attitudes ($M = 4.62$), and very good practices ($M = 4.49$). Significant positive correlations were found between knowledge and practices ($r = 0.591$, $p < .001$) and between attitude and practices ($r = 0.571$, $p < .001$). Regression analysis revealed that both knowledge ($\beta = 0.44$, $p < .001$) and attitude ($\beta = 0.33$, $p < .001$) significantly predicted SWM practices, accounting for 39% of the variance. Mediation analysis further indicated that knowledge partially mediated the link between attitude and practice, contributing 48.2% of the total effect. The findings revealed that students' strong knowledge and favorable attitudes translate into responsible waste management behaviors, with knowledge serving as a key factor in strengthening the impact of attitudes on practice. The study recommends integrating environmental education and strengthening institutional initiatives to further enhance students' sustainable waste management.*

Keywords— *behavioral factors, environmental education, ecological responsibility, higher education, sustainability*

I. INTRODUCTION

Solid waste management (SWM) is more than just a local concern; it is a global environmental issue that affects both developed and developing countries. The problem is especially evident in urban areas and institutional settings, where large volumes of waste are generated daily (Eshete et al., 2023). Colleges and universities, in particular, generate substantial amounts of waste, including paper, plastics, food scraps, and electronic materials (Owojori et al., 2022). Although many higher education institutions have introduced waste management policies, issues such as improper disposal, limited recycling efforts, and low student participation continue to pose significant challenges (Badrum & bin Mapa, 2020). Therefore, understanding students' knowledge, attitudes, and practices (KAP) regarding SWM is crucial to advancing sustainability efforts and improving institutional waste management systems.

Universities play a vital role in encouraging students to adopt sustainable habits and environmental awareness. College students, as future professionals and decision-makers, influence how society views and manages waste (Ajieh et al., 2024). However, studies reveal a gap between what students know about waste management and how they actually dispose of waste in daily life (Shaker et al., 2024). Factors such as school regulations, personal attitudes toward sustainability, and access to proper disposal facilities all contribute to this gap between knowledge and practice (Abushammala & Ghulam, 2022). To build a culture of responsible waste management within higher education institutions, these factors must be addressed effectively.

Having a positive attitude toward waste management has been found to influence students' participation in sustainable activities such as recycling and waste segregation (Gregorio et al., 2024). Despite awareness of the environmental impact of improper disposal, many students fail to act accordingly (Crowley, 2024). Convenience, lack of motivation, and limited institutional reinforcement often hinder consistent waste management behavior (Langit et al., 2024). Although attitude is a strong predictor of behavior, it does not always translate into concrete action.

This study introduces knowledge as a mediating factor that connects students' positive attitudes to their actual waste management behavior. While both knowledge and attitude are essential, the research proposes that students' knowledge of solid waste management (SWM) enhances the effect of attitude on practice. In other words, knowledge serves as the key that transforms environmental awareness and intent into consistent, sustainable behavior.

Higher education institutions have a significant influence on shaping students' waste management habits through their policies, programs, and facilities. Many universities worldwide have launched recycling programs, waste-reduction initiatives, and awareness campaigns to encourage sustainable waste disposal practices (Teodoro et al., 2022). Research indicates that institutions with well-organized SWM programs usually have students who are more actively involved in environmental efforts (Ajieh et al., 2024). However, challenges such as limited waste collection facilities, weak policy enforcement, and minimal student participation can reduce the effectiveness of these programs (Badrum & Mapa, 2021). Strengthening institutional waste policies while supporting student-led sustainability projects can significantly improve campus environmental performance.

Students' knowledge and participation in SWM also vary by academic background. Studies show that students taking environmental science courses tend to have greater awareness and engagement than those in non-environmental fields (Reyes & Madrigal, 2020). This highlights the importance of designing environmental education that reaches all college students, regardless of their program (Abushammala & Ghulam, 2022). Universities can nurture a more environmentally conscious community by integrating sustainability concepts into both classroom and extracurricular activities.

Poor waste management practices bring serious consequences to both human health and the environment. Improper disposal contributes to pollution, greenhouse gas emissions, and the spread of diseases (Ajieh et al., 2024). In developing countries like the Philippines, much of the waste is still mismanaged, ending up in landfills, rivers, and oceans (Badrum & bin Mapa, 2021). Encouraging students to reduce, segregate, and recycle waste is a vital step in minimizing these harmful effects and working toward a sustainable future.

The success of waste management programs within universities depends on the combined efforts of both institutions and students. Studies show that campuses with student-driven sustainability initiatives achieve higher recycling and segregation rates than those relying solely on administrative efforts (Gregorio et al., 2024). When students participate in these initiatives, they develop a sense of accountability and influence their peers to do the same (Crowley, 2024). This underscores the need for institutional policies and student involvement to work hand in hand to build lasting engagement in sustainability.

Technology also plays an increasingly important role in improving SWM in universities. Recent innovations such as smart bins with segregation sensors, waste-to-energy systems, and mobile tracking apps have proven effective in enhancing waste management efficiency (Langit et al., 2024). Integrating these technologies with strong institutional support and active student participation can significantly boost campus sustainability. Collaborations among schools, local governments, and environmental organizations can further expand students' involvement in real-world environmental initiatives.

Although there is already a considerable body of research on solid waste management and student behavior, few studies focus on the mediating role of knowledge in the relationship between attitude and practice. This study aims to fill that gap by investigating how knowledge strengthens the link between students' environmental attitudes and their actual waste management practices. The findings are expected to identify key factors that promote behavioral change and provide practical recommendations for higher education institutions to create more effective and sustainable waste management systems.

Theoretical Framework

This study is anchored on two major theories: the Waste Management Hierarchy Theory and the Theory of Planned Behavior (TPB) (Ajzen, 1991), which together explain how students' knowledge, attitudes, and practices influence their solid waste management behaviors.

The Waste Management Hierarchy Theory emphasizes a step-by-step approach that prioritizes waste prevention, followed by reduction, reuse, recycling, and, as a last resort, disposal (Kumar et al., 2009). It serves as a guide for efficiently managing waste while reducing environmental damage. By applying this framework, the study aims to examine how students' awareness and participation in SWM contribute to sustainable waste reduction, recycling, and resource recovery in universities.

Meanwhile, the Theory of Planned Behavior (TPB) explains that individual actions are shaped by attitudes, perceived social norms, and perceived behavioral control (Ajzen, 1991). The theory suggests that even if students possess adequate knowledge, they may not always act sustainably unless they feel capable of doing so and receive sufficient support from their surroundings. Prior studies have found that students with strong positive attitudes toward SWM are more likely to engage in practices such as waste segregation and recycling (Gregorio et al., 2024).

The Knowledge-Attitude-Practice (KAP) Model further strengthens this framework by providing a structured framework for understanding how knowledge influences behavior. In this model, *knowledge* refers to awareness of environmental issues and SWM policies, *attitude* covers one's sense of responsibility and willingness to engage, and *practice* refers to actual behaviors. According to the KAP model, knowledge and attitude are key predictors of behavior, making it highly relevant for examining how these variables affect students' waste management habits.

However, previous studies have also shown that knowledge alone does not always lead to proper waste practices due to external barriers such as a lack of motivation, poor infrastructure, or weak institutional policies (Shaker et al., 2024; Crowley, 2024). Hence, this study combines TPB and the KAP model to explore the factors that influence students' participation in SWM and how universities can enhance sustainability through both educational and policy-based approaches.

Conceptual Framework

Understanding students' knowledge, attitudes, and practices regarding solid waste management is crucial in improving sustainability programs within universities. Students play a vital role in building sustainable habits, but their actions are shaped by awareness, institutional policies, and perceived control over how they handle waste (Ajzen, 1991).

While many students are aware of proper waste management, not all are able to put this knowledge into practice due to obstacles such as inadequate facilities, convenience, or lack of motivation (Gregorio et al., 2024). Exploring these behavioral gaps can help institutions design targeted interventions to encourage more responsible disposal habits.

Student engagement in waste programs is also influenced by the extent of their exposure to school-based initiatives and the degree of institutional support they feel (Ajieh et al., 2024). When students see that their universities provide the proper

facilities and value their efforts, they are more likely to maintain sustainable behaviors.

Waste mismanagement has serious consequences for both the environment and public health (Badrum & bin Mapa, 2021). To address this, universities must take a multi-layered approach that includes education, strict policy enforcement, and active participation. Schools that incorporate sustainability into their courses and extracurricular programs tend to produce more environmentally responsible graduates (Reyes & Madrigal, 2020).

Technological innovation also enhances SWM implementation. The use of smart bins, waste-to-energy systems, and digital monitoring tools improves waste disposal efficiency (Langit et al., 2024). When combined with student-led initiatives, these innovations help cultivate a culture of environmental responsibility on campus.

Overall, this study examines the factors affecting students' engagement in SWM by analyzing their knowledge, attitudes, and practices. The results are expected to guide universities in strengthening their policies, developing environmental education programs, and promoting student-driven sustainability initiatives. By doing so, institutions can foster lifelong environmental stewardship and contribute to a cleaner, more sustainable future.

The schematic diagram of the study presents the proposed relationships among knowledge, attitude, and solid waste management (SWM) practices of college students (see Fig. 1). In this model, knowledge serves as a mediating variable that connects and influences both attitude and practice, emphasizing its key role in promoting responsible waste management behavior. The diagram shows that attitude has a direct impact on practice, while knowledge partially mediates this relationship. This framework provides a foundation for understanding how both cognitive and emotional factors shape students' sustainable waste-management actions.

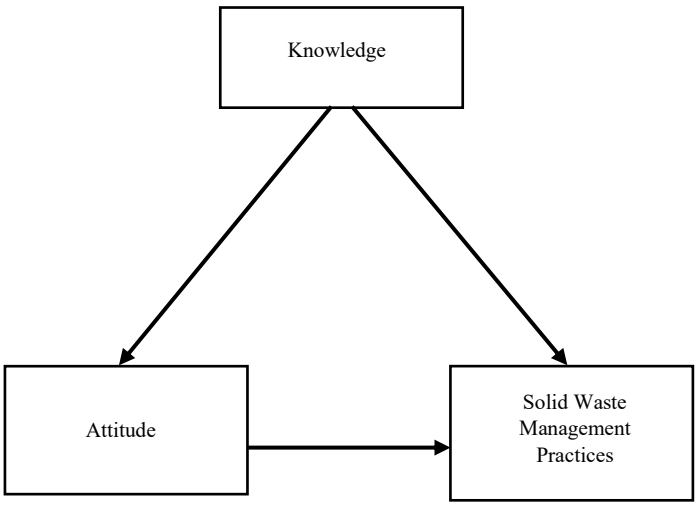

Figure 1. Schematic Diagram of the Study

Research Questions

This study examined the knowledge, attitudes, and practices (KAP) regarding solid waste management among college students at a higher education institution. Specifically, it sought to address the following questions:

1. What does the student know about solid waste management?
2. What is the student's attitude toward solid waste management?
3. What are the students' waste management practices?
4. What is the significant relationship between students' knowledge and practices on how they manage waste?
5. What is the significant relationship between students' attitudes and practices on how they manage waste?
6. Which among the independent variables (knowledge, attitudes) predicts singly or in combination with single waste management?
7. What is the mediating role of knowledge in the relationship between students' attitudes and their solid waste management practices?

II. METHODS

Research Design

This study employed a descriptive-correlational quantitative design. The descriptive part of the design focused on identifying and explaining the characteristics of the participants and variables without manipulating any of them (Siedlecki, 2020). Meanwhile, the correlational component was used to examine and predict how the variables are related to one another (Seeram, 2019). This design was deemed appropriate because it enabled the researchers to describe students' knowledge, attitudes, and practices (KAP) regarding solid waste management (SWM) and to explore how these elements interact. Through this approach, the study aimed to gain meaningful insights into how students' understanding and perceptions influence their actual waste management behaviors.

Research Setting

The study was conducted at a non-sectarian university in Ozamiz City, Misamis Occidental, recognized for its long-standing commitment to quality education. The institution, which received "Autonomous Status" from the Commission on Higher Education (CHED) in 2019, offers a broad range of academic programs—covering 29 fields of study, including graduate and basic education. Several of its programs, including the College of Education, Criminology, and Information Technology, have been recognized as Centers of Development.

The university has also earned notable distinctions, including the "Most Number of Accredited Programs in Region X" from the Philippine Association of Colleges and Universities Commission on Accreditation (PACUCOA) for two consecutive years. Additionally, it has maintained ISO 9001:2015 certification and an excellent rating from DNV, further demonstrating its dedication to upholding international educational standards.

Because of its strong reputation, the university attracts a diverse student population, not only from Misamis Occidental but also from nearby provinces. It is also worth noting that many of these students experienced the major floods that struck the region between late December 2022 and early January 2023,

which may have heightened their awareness of environmental issues and disaster management.

Respondents of the Study

The study participants were 369 students, selected through stratified random sampling. This sampling technique ensured that students from various academic programs were fairly represented. The selection criteria were as follows: (1) students are enrolled in the second semester of the SY 2024-2025; (2) willing to participate in the study; (3) students should be from various academic programs to ensure diversity, and (4) completion of at least one semester at the institution. Before data collection began, the researchers ensured that all respondents met these requirements to ensure the reliability and inclusiveness of the sample.

Research Instruments

The study utilized the following questionnaires as data-gathering instruments:

Knowledge of Solid Waste Management Questionnaire (Appendix A): This questionnaire measured students' knowledge regarding environmental waste disposal issues related to SWM and their understanding of sustainable waste management methods. The instrument was an adapted and modified version of the questionnaire developed by Eshete et al. (2023) in their study titled *"Knowledge, Attitudes, and Practices on Household Solid Waste Management and Associated Factors in Gelemso Town, Ethiopia."*.

Items are constructed using a 5-point Likert scale format, and the students responded to the statements on a scale ranging from Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). The instrument comprised 10 items assessing students' knowledge of SWM. The results were used to evaluate students' knowledge of environmental issues and SWM in their institutions. A pilot test evaluated its appropriateness. For reliability, the questionnaire underwent a Cronbach's alpha test, yielding a value of 0.703, indicating consistency. The results were used to evaluate the students' knowledge of SWM in their institution.

In determining the perceived SWM Knowledge, the following scale was used:

Responses	Continuum	Interpretation
5- Strongly Agree	4.21 - 5.00	Very High
4- Agree	3.41 - 4.20	Moderately High
3- Neutral	2.61 - 3.40	High
2- Disagree	1.81 - 2.60	Low
1- Strongly Disagree	1.00 - 1.80	Very Low

B. Attitudes Toward Solid Waste Management Questionnaire (Appendix B): The instrument assessed the students' beliefs about waste management, their willingness to engage in sustainability efforts, and their sense of responsibility. Items are constructed using a 5-point Likert scale format, and the students responded to the statements on a scale ranging from Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). The instrument consisted of 10 items related to students' attitudes towards SWM. A pilot test evaluated its appropriateness. For reliability, the questionnaire underwent a Cronbach's alpha test, yielding a value of 0.706, indicating consistency.

The results were used to evaluate the students' attitudes towards SWM in their institution.

In determining the perceived SWM Attitudes, the following scale was used:

Responses	Continuum	Interpretation
5- Strongly Agree	4.21 - 5.00	Very Good
4- Agree	3.41 - 4.20	Good
3- Neutral	2.61 - 3.40	Fair
2- Disagree	1.81 - 2.60	Poor
1- Strongly Disagree	1.00 - 1.80	Very Poor

C. Waste Management Practices Questionnaire (Appendix C): The tool evaluated students' participation in waste management practices, such as recycling, waste segregation, and engagement in campus sustainability programs. Items were constructed using a 5-point Likert scale format, and the students responded to the statements on a scale ranging from Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). The instrument comprises 10 items related to waste segregation, waste reduction, waste disposal, and SWM initiatives. A pilot test evaluated its appropriateness. For reliability, the questionnaire underwent a Cronbach's alpha test, yielding a value of 0.706, indicating consistency. The results were used to evaluate the students' waste management practices in their institutions.

In determining the perceived SWM Practices, the following scale was used:

Responses	Continuum	Interpretation
5- Strongly Agree	4.21 - 5.00	Very Good
4- Agree	3.41 - 4.20	Good
3- Neutral	2.61 - 3.40	Fair
2- Disagree	1.81 - 2.60	Poor
1- Strongly Disagree	1.00 - 1.80	Very Poor

Data Collection

Prior to data collection, the researcher sought formal permission to conduct the study by submitting letters to the School Principal of Ozamiz City National High School. Upon approval, additional permissions were secured from the Science Department Head and the Grade 9 class adviser. Parental consent forms and student assent forms were distributed to ensure voluntary and ethical participation in the study.

Data collection began with the administration of a pretest quiz containing essay questions to determine students' baseline ability to explain physics concepts using scientific reasoning. The pretest results served as the basis for comparison with post-intervention outcomes.

Following the pretest, the Think–Pair–Share strategy was implemented over several Grade 9 Science lessons. During each lesson, students engaged in the Think phase by independently responding to physics questions, the Pair phase by discussing their ideas with a partner, and the Share phase by presenting explanations to the class. This structured process encouraged active participation, peer interaction, and explanation of physics concepts.

At the end of the intervention period, a posttest quiz with parallel essay questions was administered to measure changes in students' ability to explain physics concepts. After completing the posttest, students answered the Survey Questionnaire to provide feedback on their learning experiences and perceptions of the Think–Pair–Share strategy.

All data collected from the pretest and posttest quizzes and survey questionnaires were compiled, organized, and prepared for statistical analysis to determine the effectiveness of the Think–Pair–Share strategy in enhancing Grade 9 students' ability to explain physics concepts.

Ethical Considerations

This study adhered to the ethical guidelines outlined in Republic Act No. 10173, also known as the Data Privacy Act of 2021, emphasizing the importance of safeguarding personal information and respecting participants' privacy and data protection rights. Additionally, the ethical considerations from Bryman, Bell, and Harley (2022) were followed to ensure the integrity of the study. Participants were not harmed during the study, and informed consent was obtained prior to data collection. The consent form outlined the study's objectives, benefits, and potential risks, ensuring transparency. Participants had the right to withdraw from the study without penalty, and their responses were kept confidential. Maintaining anonymity and confidentiality was a top priority throughout the research process. All data were securely stored, and identifying information was not shared. The study avoided any form of misleading information and biased interpretation of the data. Any potential conflicts of interest or affiliations related to the research were disclosed. All communication regarding the study was conducted honestly and transparently, and participants were encouraged to contact the researchers with any questions or concerns. These measures ensured that participants' privacy was respected and that the study adhered to the highest ethical standards.

Data Analysis

The study employed the following tools to analyze data collected with Jamovi 2.4.8.

The mean and standard deviation were used to assess knowledge, attitudes, and practices.

Frequency and percentage were employed to determine the demographic profile of the respondents.

The Pearson Product-Moment Correlation Coefficient was applied to examine the relationship between attitude and solid waste management practices, with knowledge considered as a mediating factor.

Multiple Regression Analysis was used to examine the direct effects of attitude and knowledge on solid waste management practices. Furthermore, a mediation analysis was conducted to examine the mediating role of knowledge in the relationship between attitude and solid waste management practices, providing a comprehensive understanding of their interrelationship.

III. Results And Discussion

Level of Students' Knowledge on Solid Waste Management

Students' knowledge of solid waste management (SWM) was evaluated based on their awareness of environmental risks, waste segregation, recycling, composting, and the impacts of improper waste disposal (Table 1). The findings revealed that students demonstrated a very high level of knowledge (M = 4.60; SD = 0.32), suggesting that they were generally well-informed about proper waste management and the environmental consequences of poor disposal practices.

Specifically, students demonstrated a strong understanding of solid waste as a significant source of pollution (M = 4.71; SD = 0.55) and the health risks associated with improper disposal (M = 4.71; SD = 0.47). They also displayed excellent awareness of recyclable materials (M = 4.60; SD = 0.51) and composting methods (M = 4.48; SD = 0.62). Moreover, many recognized that illegal dumping can lead to diseases such as diarrhea and cholera (M = 4.59; SD = 0.54).

Overall, these results indicate that students have a comprehensive grasp of both the environmental and health implications of waste mismanagement. Their knowledge extends beyond theory, reflecting an understanding of practical actions such as sorting and reusing materials. However, a slightly lower mean score was observed in perceiving waste as a valuable resource (M = 4.46; SD = 0.65), suggesting that some students may still see waste primarily as something to discard rather than as something that can be reused or repurposed.

These findings align with previous research showing that knowledge, while crucial, does not automatically translate into consistent environmental behavior. Shaker et al. (2024) found that students who possess strong environmental knowledge tend to act more sustainably when supported by institutional infrastructure and social encouragement. Similarly, Crowley (2024) emphasized that continuous reinforcement and environmental engagement are necessary to turn awareness into concrete action.

TABLE 1 Students' Knowledge on Solid Waste Management (n = 370)

Indicators	M	SD	Remarks
1. I understand that solid waste is a source of pollution for the environment.	4.71	0.55	Very High
2. I understand that burning of solid wastes causes health risks (e.g., bronchitis and asthma).	4.69	0.50	Very High
3. I know that waste papers, plastic bags, pieces of metal, wood and cloths are recyclable.	4.60	0.51	Very High
4. I consider solid waste valuable.	4.46	0.65	Very High
5. I understand that solid waste is sorted and sold for recycling companies.	4.59	0.52	Very High
6. I know organic fertilizer can be prepared from solid waste.	4.48	0.62	Very High
7. I understand that the amount of solid waste can be reduced by reusing at household level.	4.57	0.57	Very High

8. I understand that illegal dumping of solid waste causes diarrhea, typhoid, and cholera.	4.59	0.54	Very High
9. I understand that sorting of solid waste at home level helps for SWM.	4.60	0.55	Very High
10. I know that improper dumping of solid wastes can eventually lead to pollution of rivers, lakes, and wells.	4.71	0.47	Very High
Overall	4.60	0.32	Very High

Scale: 4.21–5.00 (Very High); 3.41–4.19 (Moderately High); 2.61–3.39 (High); 1.81–2.59 (Low); 1.01–1.79 (Very Low)

Environmental education plays a key role in maintaining this high level of awareness. By strengthening classroom instruction, organizing campus-wide campaigns, and supporting community-based sustainability projects, institutions can further promote environmental responsibility among students. These strategies help transform knowledge into meaningful habits that contribute to sustainable solid waste management practices.

Level of Students' Attitudes Toward Solid Waste Management

Students' attitudes toward solid waste management (SWM) were evaluated based on their beliefs about waste as an environmental concern, their willingness to take action, and their sense of responsibility in ensuring proper waste disposal (Table 2). Overall, the findings showed that students had a very positive attitude toward SWM (M = 4.62; SD = 0.34). This indicates that the respondents not only recognize the importance of managing waste properly but also believe in their personal role in promoting environmental sustainability.

The results revealed that students strongly agreed that solid waste is an urgent environmental issue that requires immediate attention (M = 4.66; SD = 0.50) and that SWM should be integrated into environmental education curricula (M = 4.66; SD = 0.52). These findings highlight students' advocacy for awareness-building through education and their acknowledgment of waste management as both a local and national priority. Furthermore, students demonstrated a strong belief in collective responsibility, as reflected in their agreement that *"proper solid waste disposal is the responsibility of everyone"* (M = 4.65; SD = 0.51) and *"every household should take part in the proper collection and disposal of solid waste"* (M = 4.63; SD = 0.53).

TABLE 2 Students' Attitudes Toward Solid Waste Management (n = 370)

Indicators	M	SD	Remarks
I believe solid waste has value.	4.58	0.61	Very Good
Solid waste is one of the environmental problems that need an immediate attention.	4.66	0.50	Very Good
Solid wastes can be reduced, reused and recycled (3Rs).	4.60	0.53	Very Good
Every household should have responsibility for the proper collection and disposal of solid wastes.	4.63	0.53	Very Good
Proper solid waste disposal is the responsibility of everyone.	4.65	0.51	Very Good
Proper SWM is important for creating healthy environment.	4.64	0.53	Very Good
SWM is a burning issue in the town.	4.55	0.58	Very Good
The city government should conduct regular supervision and control on illegal dumping of solid waste in the town.	4.63	0.56	Very Good
Selling plastic waste for recycling is the best way to manage solid wastes.	4.56	0.55	Very Good
Solid waste disposal has been taught in school as part of Environmental education.	4.66	0.52	Very Good
Overall	4.62	0.34	Very Good

Scale: 4.21–5.00 (Very Good); 3.41–4.19 (Good); 2.61–3.39 (Fair); 1.81–2.59 (Poor); 1.01–1.79 (Very Poor)

Although all indicators fell within the "Very Good" category, slightly lower mean scores were recorded for more practical behaviors such as selling plastic waste for recycling (M = 4.56; SD = 0.55) and perceiving SWM as a critical issue within their local communities (M = 4.55; SD = 0.58). This suggests that while students hold strong pro-environmental attitudes, their degree of concern or engagement may vary depending on how closely they experience waste-related problems in their surroundings.

The students' positive attitudes align with the findings of Shaker et al. (2024) and Gregorio et al. (2024), who emphasized that developing environmental values among young people is essential in closing the gap between awareness and actual behavior. Consistent with the Theory of Planned Behavior (Ajzen, 1991), attitude remains one of the strongest predictors of behavioral intention. When students deeply value sustainability, they are more likely to engage in responsible waste management actions.

Overall, these findings highlight the need to continue nurturing environmental responsibility among students through continuous education, active participation, and community-based projects. Since students already display favorable attitudes, educational institutions should focus on maintaining this momentum by providing real-life opportunities to practice sustainable habits, both inside and outside the classroom.

Level of Students' Practices on Solid Waste Management

Students' actual practices in solid waste management (SWM) were examined with respect to their waste segregation habits, recycling and reduction efforts, and participation in environmentally sustainable activities (Table 3). The findings revealed an excellent level of practice (M = 4.49; SD = 0.38), indicating that most respondents consistently engage in responsible environmental behaviors. This result reflects the positive impact of ongoing awareness programs and institutional initiatives that promote proper waste handling and disposal within the university.

Among the indicators, the highest mean score was obtained for properly separating biodegradable and non-biodegradable waste before disposal (M = 4.66; SD = 0.50), showing that waste segregation is a common and well-practiced habit among students. Likewise, adherence to school waste segregation policies (M = 4.57; SD = 0.54) and active participation in the 3Rs—reduce, reuse, and recycle (M = 4.54; SD = 0.56) also

received excellent ratings. These findings suggest that students not only understand the principles of SWM but also integrate them into their daily routines, demonstrating that simple, consistent actions can lead to sustainable environmental behavior.

Indicators such as reducing waste production through material reuse (M = 4.54, SD = 0.54) and ensuring waste containers are conveniently placed around the house (M = 4.50, SD = 0.59) further suggest that students are proactive in minimizing waste generation and improving collection efficiency. The practice of avoiding solid waste burning (M = 4.44; SD = 0.66) also reflects growing environmental awareness regarding the harmful effects of open burning on air quality.

However, slightly lower scores were recorded for access to door-to-door waste collection services (M = 4.28; SD = 0.81) and composting degradable materials (M = 4.41; SD = 0.67). These results suggest that while students have positive attitudes and intentions toward SWM, their ability to fully implement certain practices may be affected by external factors—such as limited local waste collection systems or lack of available composting facilities.

The overall excellent rating supports the findings of Abushammala and Ghulam (2022), who emphasized that environmental education and community-based initiatives significantly improve students' waste management behaviors. Consistent with the Theory of Planned Behavior (Ajzen, 1991), positive attitudes combined with perceived behavioral control help transform awareness into actual action. Thus, the strong SWM practices observed in this study can be seen as outcomes of students' environmental knowledge, sense of responsibility, and the supportive institutional environment in which they are embedded.

These findings highlight the importance of continuously reinforcing sustainable practices through hands-on learning, clean-up drives, and environmental partnerships. Strengthening these initiatives can deepen students' sense of environmental citizenship and encourage long-term commitment to effective solid waste management, both on campus and in their communities.

TABLE 3 Students' Practices on Solid Waste Management (n = 370)

Indicators	M	SD	Remarks
1. I properly separate biodegradable and non-biodegradable waste before disposing of it.	4.66	0.50	Very Good
2. I try to reduce my waste production by reusing materials whenever possible.	4.54	0.54	Very Good
3. I practice reduce, reuse and recycle strategy for SW or use 3Rs.	4.54	0.56	Very Good
4. I follow my school's waste segregation policies when disposing of trash.	4.57	0.54	Very Good
5. I have access to door to door waste collection services.	4.28	0.81	Very Good
6. I make sure to place waste containers conveniently around the house.	4.50	0.59	Very Good
7. I avoid the burning of solid waste.	4.44	0.66	Very Good
8. I form compost from degradable waste.	4.41	0.67	Very Good
9. I sort SW during storage and disposal.	4.50	0.59	Very Good
10. I remind my friends and family to follow proper waste disposal.	4.41	0.66	Very Good
Overall	4.49	0.38	Very Good

Scale: 4.21–5.00 (Very Good); 3.41–4.19 (Good); 2.61–3.39 (Fair); 1.81–2.59 (Poor); 1.01–1.79 (Very Poor)

Significant Relationship Between Students' Knowledge and Practices on Solid Waste Management

The results showed a positive and highly significant relationship between students' knowledge and their solid waste management (SWM) practices ($r = 0.591$, $p < 0.001$) (Table 4). This indicates that students who possess a deeper understanding of waste management concepts—such as segregation, recycling, composting, and the environmental and health effects of improper waste disposal—are more likely to consistently engage in proper waste management behaviors. For example, students who are familiar with the 3Rs (reduce, reuse, recycle) tend to separate biodegradable from non-biodegradable waste, avoid open burning, and actively participate in composting activities.

This finding supports the Knowledge-Attitude-Practice (KAP) model, which emphasizes that knowledge serves as the foundation for behavioral change. It also aligns with the results of previous studies by Ajieh et al. (2024) and Reyes and Madrigal (2020), who found that higher levels of environmental knowledge among young people are strong predictors of sustainable waste management behaviors. However, while knowledge is a key factor, it does not automatically translate into consistent action. Its effectiveness is strengthened when complemented by institutional support—such as clearly labeled bins, regular awareness campaigns, and strict enforcement of waste management policies.

These results suggest that enhancing students' environmental literacy through curriculum integration, seminars, and student-driven initiatives can significantly improve their waste management practices. Universities should therefore go beyond merely teaching environmental concepts; they must also create supportive environments that empower students to apply their knowledge through real-life, sustainable actions.

TABLE 4 Significant Relationship Between Students' Knowledge and Practices on Solid Waste Management (n = 370)

Variable	r-value	p-value	Remarks
Knowledge & Practices on Solid Waste Management	0.591	0.001	Highly Significant

*Note: *** $p < 0.001$ (Highly Significant); ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not Significant)*

Significant Relationship Between Students' Attitude and Practices on Solid Waste Management

Table 5 shows the correlation between students' attitudes and their actual practices related to solid waste management (SWM). The analysis revealed an r-value of 0.571 with a p-

value of 0.001, indicating a very highly significant relationship between the two variables. This means that students with stronger pro-environmental beliefs and a greater sense of responsibility toward waste management are more likely to put those beliefs into practice through proper waste disposal and sustainable practices.

This finding supports the Theory of Planned Behavior (TPB), which highlights the crucial role of attitude in influencing behavioral intentions and actual behavior. In this context, students who have developed positive attitudes—such as a strong sense of accountability, environmental concern, and willingness to participate—tend to engage more actively in SWM initiatives. Strengthening these positive attitudes, therefore, can lead directly to better waste management practices.

The results are consistent with those of Langit (2023) and Gregorio (2024), who observed that students become more involved in pro-environmental behavior when institutions implement values-based, participatory programs, such as sustainability clubs, environmental campaigns, and peer-led initiatives. These activities not only build awareness but also foster a sense of community responsibility, translating positive attitudes into real, consistent environmental actions.

TABLE 5 Significant Relationship Between Students' Attitude and Practices on Solid Waste Management (n = 370)

Variable	r-value	p-value	Remarks
Attitude & Practices on Solid Waste Management	0.571	0.001	Highly Significant

*Note: *** p < 0.001 (Highly Significant); ** p < 0.01 (Highly Significant); * p < 0.05 (Significant); p > 0.05 (Not Significant)*

Predictors of Students' Solid Waste Management Practices Based on Knowledge and Attitudes

The regression analysis revealed that both knowledge (β = 0.44, p < .001) and attitude (β = 0.33, p < .001) significantly predicted students' solid waste management (SWM) practices, jointly accounting for 39% of the variance in behavior. This means that students with a stronger understanding of waste management concepts and more positive environmental attitudes are more likely to practice responsible waste-disposal behaviors, such as segregation, recycling, and composting. Among the two, knowledge emerged as the slightly stronger predictor, suggesting that while attitudes serve as motivation, actionable knowledge provides the guidance needed to turn those intentions into consistent, meaningful practices.

These findings align with the Theory of Planned Behavior (Ajzen, 1991) and the Knowledge-Attitude-Practice (KAP) framework, both of which emphasize that cognitive (knowledge) and affective (attitude) factors jointly shape behavioral outcomes. The results are also consistent with previous research by Shaker et al. (2024) and Gregorio et al. (2024), who highlighted that combining environmental literacy with value formation is crucial for promoting sustainable waste management behaviors among students.

TABLE 6 Predictors of Students' Solid Waste Management Practices Based on Knowledge and Attitudes

Predictors	Coef (β)	Ɛ Coef	t- value	p-value
(Constant)	0.94	0.23	4.02	< .001
Knowledge	0.44	0.07	6.22	< .001
Attitude	0.33	0.07	4.92	< .001
Adjusted r^2		0.39		
F value		117		
p-value		<.001		
Students' Solid Waste Management Practice = 0.936 + 0.444 * (Knowledge) + 0.327 * (Attitude)				

The results suggest that universities should aim to strengthen both the cognitive and affective aspects of environmental education. Integrating SWM concepts into academic subjects and reinforcing them through values-based learning and experiential activities can enhance their long-term behavioral impact. Since knowledge accounted for a slightly greater share of behavioral influence, institutions should prioritize hands-on, practice-oriented approaches, such as workshops, awareness drives, and campus-wide sustainability programs, such as recycling campaigns or eco-leadership initiatives.

Moreover, the analysis shows that 61% of students' waste management behaviors may be influenced by factors such as institutional policies, available facilities, and prevailing social norms. This highlights the importance of adopting a comprehensive, multi-level strategy that combines education, policy enforcement, and community engagement to create a culture of sustainable waste management within and beyond the university setting.

Mediating Role of Knowledge in the Relationship Between Students' Attitudes and Practices on Solid Waste Management

The mediation analysis confirmed that knowledge partially mediates the relationship between students' attitudes and their solid waste management (SWM) practices (see Fig. 2). This means that students who hold positive attitudes toward environmental responsibility are more likely to seek out and apply relevant knowledge, which then increases their likelihood of engaging in responsible waste management behaviors such as segregation, recycling, and composting. This progression from attitude → knowledge → practice illustrates how motivation evolves into concrete action through learning and awareness.

The analysis revealed that the indirect effect accounted for 48.2% of the total influence, showing that knowledge functions as a cognitive bridge that strengthens the link between attitude and behavior. For instance, a student who firmly believes in environmental protection (attitude) may take the initiative to learn about composting techniques (knowledge), which then encourages them to consistently separate biodegradable waste at home (practice).

At the same time, the direct effect of attitude, accounting for 51.8% of the influence, indicates that strong environmental values can also drive sustainable behavior, even in the absence of extensive technical understanding. This finding reinforces the idea that both knowledge and attitude play essential, complementary roles—where knowledge refines and directs action, while attitude provides the motivation that sustains it.

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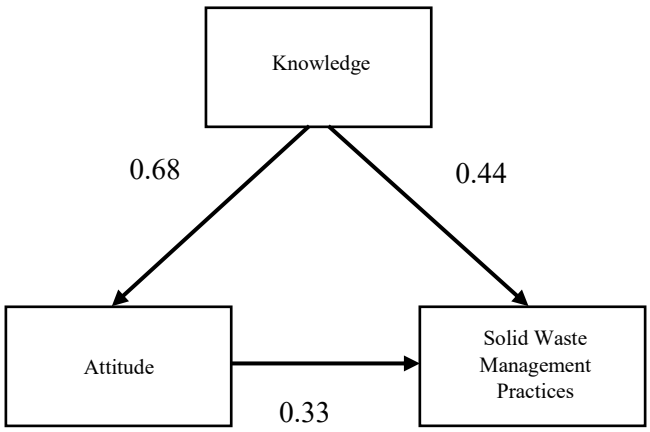

Figure 2. Mediation Analysis of Knowledge Between Attitude and Solid Waste Management Practices

This dual pathway aligns with both the Theory of Planned Behavior (Ajzen, 1991) and the Knowledge-Attitude-Practice (KAP) model, which together highlight that belief and information are equally important in shaping sustainable behaviors. The findings emphasize that while positive attitudes foster the willingness to act, knowledge refines, directs, and sustains these actions in everyday practice.

These results suggest that educational programs should move beyond simply cultivating environmental attitudes—they must also equip students with practical, actionable knowledge. Universities can achieve this by combining values-based campaigns (such as eco-leadership activities and peer-led advocacy) with knowledge-building initiatives, such as workshops on waste segregation and campus-wide recycling programs. By promoting this natural flow from attitude → knowledge → practice, institutions can strengthen students' capacity to adopt consistent, meaningful, and sustainable waste management behaviors.

TABLE 7 Mediation analysis on the role of knowledge in the relationship between students' attitudes and their solid waste management practices

Effect			Label Estimate		SE	95% Confidence Interval				
						Lower	Upper	Z	p	% Mediation
Indirect			a x b	0.304	0.0508	0.204	0.403	5.98	< .001	48.2%
Direct			c	0.327	0.0662	0.198	0.457	4.94	< .001	51.8%
Total			c+a x b	0.631	0.0473	0.538	0.723	13.34	< .001	100.0%
Path Estimates										
Attitude	→	Knowledge	a	0.684	0.0329	0.620	0.749	20.83	< .001	
Knowledge	→	Practices	b	0.444	0.0711	0.304	0.583	6.24	< .001	
Attitude	→	Practices	c	0.327	0.0662	0.198	0.457	4.94	< .001	

IV. Summary, Conclusions, And Recommendations

Summary of Findings

This study examined the knowledge, attitudes, and practices (KAP) of 370 college students toward solid waste management (SWM) in a higher education institution. Data were gathered using validated Likert-scale instruments and analyzed using descriptive statistics, correlation, multiple regression, and mediation analysis. The following are the findings based on the statement of the problem:

1. Level of Knowledge – Students demonstrated a *very high level of knowledge* on SWM (M = 4.60; SD = 0.32), particularly in understanding the harmful effects of improper disposal and the importance of waste segregation and recycling.
2. Level of Attitude – Students demonstrated a *very good attitude* toward SWM (M = 4.62; SD = 0.34), reflecting a strong sense of responsibility and positive beliefs about proper waste disposal.
3. Level of Practices – Students reported *very good levels of SWM practices* (M = 4.49; SD = 0.38), particularly in waste segregation, avoiding burning, and practicing the 3Rs.
4. Relationship between Knowledge and Practices – A significant positive relationship was found between students' knowledge and practices ($r = 0.591$, $p < .001$), suggesting that greater knowledge is associated with more consistent, sustainable behaviors.
5. Relationship between Attitude and Practices – A significant positive relationship was also found between students' attitudes and practices ($r = 0.571$, $p < .001$), confirming that students with more favorable attitudes toward SWM are more likely to practice responsible waste management.
6. Predictors of Practices – Both knowledge ($\beta = 0.44$, $p < .001$) and attitude ($\beta = 0.33$, $p < .001$) significantly predicted students' SWM practices, explaining 39% of the variance. Knowledge was found to be the slightly stronger predictor.
7. Mediating Role of Knowledge – Mediation analysis revealed that knowledge *partially mediated* the relationship between attitude and practice, accounting for 48.2% of the total effect. This indicates that while attitudes directly influence behavior, knowledge strengthens and sustains this effect.

Conclusions

Based on the findings, the study draws the following conclusions:

1. Students possess a strong understanding of solid waste management and its environmental implications.
2. Their positive attitudes reflect a high level of environmental awareness and responsibility.
3. These knowledge and attitude levels are translated into consistent, responsible waste practices.
4. Both knowledge and attitude are significant predictors of behavior, with knowledge showing a slightly greater influence.

5. Knowledge serves as a partial mediator between attitude and practice, reinforcing its importance in converting intent into action.
6. The findings affirm the relevance of the KAP model and the Theory of Planned Behavior in understanding students' SWM behavior.

Recommendations

In light of the conclusions, the following recommendations are proposed:

1. School administration and curriculum planners integrate solid waste management (SWM) education across general and program-specific courses. This can be done by embedding SWM concepts into syllabi, classroom activities, and course outcomes to promote environmental literacy across all disciplines.
2. Faculty members and student affairs coordinators implement practical initiatives such as clean-up drives, recycling challenges, and eco-leadership programs. These activities will help students translate positive attitudes into concrete, sustainable waste management behaviors.
3. Campus facilities staff and school administrators improve waste management infrastructure by installing labeled segregation bins, composting stations, and recycling centers in strategic areas. Clear signage and accessible locations will increase student compliance with proper waste disposal practices.
4. Faculty and student organizations facilitate targeted knowledge-building workshops and informational campaigns. These programs can focus on equipping students, especially those with strong environmental attitudes but limited knowledge, with specific skills and strategies to carry out effective waste management practices.
5. School administration and student councils establish digital and on-campus feedback mechanisms such as surveys, mobile apps, and suggestion boxes. These tools will monitor students' SWM behavior, gather insights, and inform improvements in institutional policies and strategies.
6. Student organizations and peer leaders lead awareness campaigns and peer-modeling activities to promote SWM best practices. Leveraging peer influence through student-led initiatives can increase engagement and foster a culture of environmental responsibility within the campus.
7. Future researchers and academic institutions will conduct extended studies exploring additional variables, such as behavioral control, environmental concern, and institutional support. These efforts will broaden understanding of what drives sustainable behavior and strengthen the theoretical model.
8. Educators and research practitioners replicate this study in other academic institutions, localities, or educational levels to assess the generalizability of the findings. Comparative analysis can help identify patterns and develop broader recommendations for SWM practices in diverse contexts.

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