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Students' Awareness and Perception of School Campus Solid Waste Management: A Q-sort Photo Analysis

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Abstract

Solid waste mismanagement within school environments reflects not only ecological challenges but also the level of environmental awareness and responsibility among learners. This study aimed to determine students' awareness and perceptions of campus solid waste management through Q-sort Photographic Analysis using Q methodology. Specifically, it examined the underlying patterns of students' perceptions of solid waste management conditions in the school environment, identified the highest- and lowest-ranked photographs across extracted viewpoints, and assessed students' awareness based on average Q-sort rank scores. The findings revealed diverse yet interconnected perceptions among students, represented by seven extracted factors that collectively explained 84.77% of the total variance. Factor 1 emerged as the dominant viewpoint, accounting for 33.72% of the variance, indicating a shared perspective among respondents. The highest-ranked photographs demonstrated students' strong recognition of visible waste-related concerns, including littered areas, overflowing garbage bins, and improper waste storage. Conversely, lower-ranked photographs indicated limited attention toward less visible waste concerns and positive environmental behaviors. The results showed the highest awareness for Photo 8 (M = 0.8571) and lower recognition of positive practices such as litter collection. Overall, students exhibit strong awareness of visible waste problems but need enhanced environmental education initiatives promoting segregation, recycling, prevention, and active stewardship.

Keywords: *Subjective Analysis, Photographic Q-Sort, Opinion Mapping, Environmental Awareness, Campus Waste Management.*

I. INTRODUCTION

Solid waste management (SWM) has long been recognized as one of the most pressing environmental challenges worldwide, driven by rapid urbanization, population growth, industrialization, and shifting consumption patterns. Improper waste disposal contributes to pollution, environmental degradation, and climate change, making effective waste management strategies essential for sustainable development (Debrah et al., 2020).

Awareness programs within schools are particularly significant, as they help learners understand their role in the broader environment. Training, seminars, workshops, and participatory activities cultivate environmental consciousness, preparing students to become responsible citizens and stewards of ecological sustainability. Determining the level of awareness regarding SWM is therefore crucial, as it allows educators and policymakers to assess the effectiveness of existing programs, identify gaps, and design stronger interventions (Yukalang et al., 2020; Rossit & Nesmachnow, 2022).

In the Philippine context, Republic Act No. 9003, the Ecological Solid Waste Management Act of 2000, underscores the importance of waste segregation, recycling, and environmental education. Despite this legal framework, studies reveal persistent gaps in student behavior, particularly in waste disposal practices and environmental discipline. Research suggests that while many students demonstrate moderate to high awareness of SWM, actual implementation remains inconsistent due to institutional, behavioral, and infrastructural limitations (Aque & Salic-Hairulla, 2025; Salon & Salic-Hairulla, 2025).

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Recent literature emphasizes that awareness, positive attitudes, and good practices are inseparable components of environmental behavior. However, most studies rely heavily on questionnaires, offering limited insight into students' deeper perceptions and leaving a gap in understanding their subjective viewpoints. Visual and participatory approaches, such as Q-sort photograph analysis, provide a more nuanced understanding of students' subjective viewpoints, making them indispensable for exploring environmental awareness in educational contexts (Sprague et al., 2021).

Beyond awareness, scholars highlight the importance of behavioral reinforcement and institutional support. Goodwillie (2022) emphasize that active participation in recycling initiatives and community cleanups strengthens environmental responsibility more than classroom instruction alone. These findings suggest that awareness must be paired with experiential learning opportunities to achieve lasting behavioral change.

Moreover, the link between waste management and climate change mitigation has become increasingly relevant. Proper resource recovery, recycling, and segregation reduce greenhouse gas emissions and conserve natural resources, directly supporting sustainability goals (United Nations Environment Programme, 2021). Integrating climate change education with SWM awareness can deepen students' sense of environmental responsibility and situate their actions within global sustainability efforts.

Rapid urbanization, population increase, and shifting consumption habits have made solid waste management (SWM) one of the world's most urgent environmental issues. Effective waste management techniques are crucial for sustainable development, since improper waste disposal leads to pollution, environmental deterioration, and climate change. In response to these issues, educational institutions have been acknowledged as important agents in raising students' understanding of environmental issues and motivating them to behave responsibly (Debrah et al., 2020).

The role of education in enhancing waste management awareness was emphasized by Debrah et al. (2020), who revealed that students' knowledge, attitudes, and actions about appropriate waste management are greatly enhanced by formal environmental education. Schools are a good place for young people to learn about environmental stewardship. Students become more conscious of the repercussions of inappropriate trash disposal and the significance of sustainable practices when environmental topics are incorporated into educational programs. This result emphasizes how important it is for schools to take an active role in environmental education programs.

Building upon the role of environmental education, Ferronato and Torretta (2019) argued that awareness is a fundamental component of successful waste management systems. Their review emphasized that environmentally aware communities are more likely to adopt effective waste management practices, including waste reduction, segregation, and recycling. Increased environmental awareness encourages individuals to recognize their responsibilities toward the environment and actively participate in conservation initiatives. This suggests that enhancing students' awareness can positively influence their environmental decision-making and behavior. More recently, Clark (2024) found that climate change education fosters critical climate awareness, strengthens students' environmental responsibility, and promotes active engagement in sustainability initiatives.

The relationship between environmental awareness and actual waste management behavior has been widely documented. Wu et al. (2022) found that university students with greater environmental knowledge were more likely to engage in appropriate waste management behaviors, with environmental knowledge serving as an important predictor of behavior through environmental concern and personal norms. Likewise, Panganiban-Santos and Pastrana (2021) reported that students with higher levels of waste management awareness exhibited significantly better waste disposal practices. These results suggest that raising students' awareness of environmental issues can help build sustainable waste management strategies both within and outside of the classroom. In the Philippine context, Aque and Salic-Hairulla (2025) found that senior high school students showed strong awareness of waste segregation and recycling, though gaps remained in knowledge of environmental laws.

While awareness plays an important role, researchers have noted that knowledge alone does not always result in positive environmental behavior. Debrah et al. (2021) emphasized that environmental education should be complemented by supportive school policies and practical opportunities to ensure that knowledge is translated into sustainable behavior. Furthermore, Vance-Chalcraft and Goodwillie (2022) reported that students who actively participated in environmental service-learning activities demonstrated stronger environmental responsibility than those who relied solely on classroom instruction.

The importance of environmental responsibility extends beyond waste management and directly relates to addressing climate change. According to the United Nations Environment Programme (2021), by lowering greenhouse gas emissions and decreasing environmental contamination, sustainable waste management techniques greatly aid in the mitigation of climate change. In addition to conserving natural resources, proper resource recovery, recycling, and trash segregation also lessen the quantity of waste dumped in landfills. Thus, encouraging students to manage their garbage properly can support more general environmental sustainability objectives. Supporting this perspective, Clark (2024) found that students' awareness of climate change positively influences their willingness to participate in environmental conservation and sustainability initiatives. Students who understand the relationship between human activities and climate change are more likely to adopt environmentally responsible

behaviors. Likewise, the United Nations Environment Programme (2021) emphasized that proper waste management including waste reduction, segregation, recycling, and resource recovery is an essential strategy for mitigating climate change and conserving natural resources

Baranggan and Yamba (2024) found that although students generally demonstrated positive attitudes toward environmental protection and solid waste management, some continued to exhibit improper waste disposal practices. The authors recommended strengthening environmental education and reinforcing responsible waste management through participatory and school-based interventions to bridge the gap between awareness and actual practice. Salon and Salic-Hairulla (2025) found that junior high school students had a good understanding of SWM and its environmental implications, with media exposure, school campaigns, and teacher support identified as key facilitators of awareness and behavior.

As environmental issues become increasingly complex, researchers have recognized the importance of understanding how individuals perceive and interpret these challenges. Usher et al. (2023) highlighted the usefulness of Q methodology as a participatory approach in environmental and natural resources research, emphasizing its ability to capture diverse stakeholder perspectives. Similarly, Buchholtz and Vollstedt (2024) explained that Q methodology systematically identifies subjective viewpoints by integrating qualitative and quantitative techniques, allowing researchers to examine patterns of beliefs and opinions rather than simply measuring frequencies. In conservation research, Zabala et al. (2018) further noted that Q methodology is particularly effective for exploring diverse perspectives that traditional surveys may overlook. These findings support the current study's use of Q-sort photograph analysis, which provides deeper insights into students' environmental awareness by combining visual categorization with participatory engagement.

Overall, the examined literature shows that encouraging appropriate waste management methods is intimately linked to environmental education, awareness, student involvement, institutional support, and understanding of climate change. Research repeatedly demonstrates that raising environmental awareness can have a favorable impact on students' attitudes and behaviors regarding waste management, especially when active engagement and experiential learning are included. Additionally, research backs up the Q methodology's efficacy in examining students' subjective viewpoints on environmental issues (Usher et al., 2023). These results offer a solid theoretical basis for the current study, which uses Q technique and Q-sort analysis to ascertain Abra High School students' awareness of appropriate waste management.

This research lies in its potential to inform educational institutions, and policymakers in designing more effective environmental education programs towards solid waste management in school campuses. In connection, this study positions schools not merely as sites of knowledge transmission but as transformative spaces where environmental responsibility is cultivated. By focusing on the awareness and practices of Abra High School students, the research offers localized insights that can be scaled to broader educational and community contexts, reinforcing the critical link between education, awareness, and sustainable environmental behavior.

➢ *Statement of the Problem*

This research study aimed to determine the level of students' awareness and perception of Campus Solid Waste Management through Q-sort Photographic Analysis.

- *It Specifically Sought to Answer the Following Questions:*

✓ What are the underlying patterns of students' perception regarding Solid Waste Management in school campus environmental conditions depicted in selected photographs in terms of

- The extracted factors
- Explained variances, and
- Dominant Q-sort loadings obtained through Q methodology

✓ What are the highest- and lowest-ranked photographs across the extracted factors, based on Q-sort analysis?
✓ What is the level of students' awareness of Solid Waste Management in school campus environmental conditions depicted in selected photographs based on Q-sort average rank scores?

II. METHODOLOGY

➢ *Research Design*

This study employed a descriptive research design utilizing the Q-sort methodology to examine the level of awareness of Abra High School students regarding solid waste management practices. The Q-sort technique was used to systematically study participants' viewpoints, perceptions, and awareness by asking them to rank or sort a set of statements, images, or photographs according to specific criteria. In this study, photographs depicting various solid waste management practices and environmental situations served as the Q-sample.

The use of Q-sort photograph analysis enabled the researchers to capture students' subjective interpretations and awareness of proper and improper waste management practices. Through the sorting process, participants demonstrated how they perceived different waste-related behaviors and environmental conditions, providing insights into their level of awareness and understanding of solid waste management concepts.

➢ *Research Locale and Participants*

The study was conducted at Abra High School during the School Year 2025-2026. The participants consisted of

selected students enrolled at the school who were willing to participate in the study. Sixty (60) Participants were chosen through purposive sampling to ensure that they represented the target population of learners whose awareness of solid waste management was being investigated.

➢ *Details of Procedures*

This study followed the standard procedures of Q methodology to identify and analyze students' subjective viewpoints regarding solid waste management practices within the school.

Prior to data collection, permission was secured from the school administration. Participants were informed about the purpose of the study and were assured that their responses would remain confidential and would be used solely for research purposes.

The implementation of the study consisted of six phases: (1) defining and developing the concourse, (2) developing the Q-set, (3) selecting the P-set, (4) conducting the Q-sort, (5) conducting post-Q interviews, and (6) data analysis and interpretation (Buchholtz & Vollstedt, 2024).

- *Phase 1: Defining and Developing the Concourse:*

The first phase involved the development of the concourse, which refers to the collection of ideas, opinions, and perspectives related to the research topic. To establish the concourse, the researchers designed a survey questionnaire that elicited students' experiences, observations, and perceptions regarding proper waste disposal and waste management practices within Abra High School.

Responses gathered from the participants were carefully reviewed to identify recurring themes, viewpoints, and concerns related to solid waste management. These statements served as the basis for understanding the subjective perspectives of the target population. Since Q methodology seeks to examine human subjectivity, the collection of diverse opinions was an essential component of this phase. In addition to written responses, the researchers documented actual waste management situations within the school through photographs. These photographs represented various practices and conditions associated with waste disposal, segregation, recycling, and environmental cleanliness. Together, the collected statements and photographs formed the concourse from which the Q-set was developed.

- *Phase 2: Developing the Q-Set:*

After establishing the concourse, the researchers developed the Q-set by selecting ten photographs that best represented the range of waste management conditions observed within the school environment. Each photograph was paired with a statement describing the depicted situation to provide participants with contextual understanding during the sorting activity.

The researchers then designed a Q-sort grid based on a quasi-normal distribution ranging from "least representative" to "most representative." The sorting scale consisted of five positions represented by scores of -2, -1, 0, +1, and +2. A Condition of Instruction (COI) was prepared to guide participants throughout the sorting process. The COI contained the purpose of the study, instructions for completing the Q-sort, and reminders that there were no right or wrong answers.

To facilitate data collection and ensure consistency in the sorting procedure, the photographs, score sheet, and instructions were uploaded to QMethod Software (QMethodSoftware.com), an online platform specifically designed for conducting Q methodological studies. The platform enabled respondents to complete the sorting activity efficiently while preserving the subjective nature of their responses.

- *Phase 3: Selection of the P-Set:*

The third phase involved the selection of participants, commonly referred to as the P-set in Q methodology. The researchers employed a stratified random sampling technique to ensure representation across all grade levels and genders within the school. Students were first grouped according to grade level and subsequently stratified by gender.

From each grade level, five male and five female students were randomly selected, resulting in ten participants per grade level. This process yielded a total of sixty (60) respondents. The selected participants were deemed capable of providing informed opinions regarding waste management practices because of their regular exposure to the school environment and its waste-related concerns.

- *Phase 4: Conducting the Q-Sort:*

The Q-sorting activity was administered through the online platform. Before beginning the activity, participants were instructed to carefully read the Condition of Instruction. They were informed that the objective of the activity was to rank the photographs according to their perceptions and that there were no correct or incorrect responses.

Participants examined each photograph and arranged them on the Q-sort grid according to the degree to which they considered the depicted situation representative of solid waste management practices within the school. Photographs perceived as most representative were assigned positive scores, while those perceived as least representative were assigned negative scores. Participants were allowed to review and modify their placements until they were satisfied with the final arrangement. Upon completion, the software automatically recorded each participant's Q-sort for subsequent analysis.

The photographs utilized in the Q-sort represented various waste management conditions, including improper waste segregation, overflowing garbage bins, waste disposal in drainage systems, litter collection activities,

food waste segregation, recycling practices, unattended spills, scattered plastic waste, improperly discarded food containers, and unmanaged classroom waste.

- *Phase 5: Post-Q Interview:*

Following the completion of the Q-sorting activity, selected participants were invited to participate in a post-Q interview. The purpose of the interview was to obtain deeper insights into the reasoning behind their photograph rankings and to clarify the subjective meanings associated with their sorting decisions.

Participants were asked to explain why they placed certain photographs in the highest and lowest positions on the Q-sort grid. They were encouraged to discuss their perceptions, experiences, and emotions related to the depicted waste management situations. With the participants' consent, interviews were documented and recorded to ensure the accuracy of the qualitative data gathered. The interview responses served as supplementary information for interpreting the extracted factors and understanding the viewpoints represented by each factor.

- *Phase 6: Data Analysis and Interpretation:*

The final phase involved the analysis and interpretation of the completed Q-sorts. All Q-sort data were entered into QMethod Software for statistical processing. The software generated a Pearson-by-Pearson correlation matrix to determine the degree of similarity among respondents' sorting patterns.

Factor analysis was subsequently performed to identify clusters of respondents who shared similar viewpoints. Principal component extraction and factor rotation procedures were employed to obtain a clearer factor structure. Factors with significant eigenvalues were retained and interpreted as distinct viewpoints regarding solid waste management.

The software then generated factor scores and factor arrays for each photograph. Z-scores were calculated and transformed into factor rankings ranging from the least representative to the most representative photographs within each factor. These rankings were used to identify the highest-ranked and lowest-ranked photographs associated with each extracted viewpoint. The resulting factor matrices, factor arrays, and variance statistics served as the basis for interpreting respondents' perceptions and understanding the diverse perspectives on solid waste management within the school environment.

III. DATA ANALYSIS

The data gathered from the Q-sort activity were analyzed using QMethod Software, a specialized software designed for Q methodological studies. The software generated Pearson-by-Pearson correlation matrices, factor loadings, factor scores, factor arrays, and explained variances to identify patterns of shared perceptions among respondents. Descriptive statistical techniques, including frequency counts, percentages, and average rank scores, were likewise employed to summarize and interpret the results. These statistical treatments enabled the researchers to objectively examine students' subjective viewpoints regarding solid waste management conditions depicted in the selected photographs.

For Research Problem 1, which sought to determine the underlying patterns of students' perceptions regarding solid waste management in terms of extracted factors, explained variances, and dominant Q-sort loadings, Pearson correlation analysis and Principal Component Analysis (PCA) with Varimax rotation were employed. The Pearson correlation matrix was used to determine the degree of similarity among respondents' Q-sorts, while factor analysis was utilized to identify clusters of respondents who shared similar viewpoints. The extracted factors represented distinct patterns of perception regarding solid waste management. The percentage of explained variance was used to determine the relative contribution of each factor to the overall factor structure, while dominant Q-sort loadings identified the respondents who most strongly defined each factor. The results were presented using a synthesized factor matrix table showing the extracted factors, explained variances, dominant Q-sort loadings, and corresponding descriptions of the shared viewpoints. This presentation was deemed appropriate because it summarizes the major perception patterns while highlighting the respondents who best represent each identified viewpoint.

For Research Problem 2, which sought to identify the highest- and lowest-ranked photographs across the seven extracted factors, factor scores generated from the Q-sort analysis were utilized. The software converted standardized Z-scores into factor array scores ranging from -2 to +2. Photographs assigned a score of +2 were interpreted as the most representative of a factor's viewpoint, whereas photographs assigned a score of -2 were interpreted as the least representative. The results were presented through separate tables showing the highest-ranked and lowest-ranked photographs, together with their descriptions and corresponding factor scores. This method of presentation allowed for a clearer interpretation of the environmental conditions that respondents most strongly associated with, or least associated with, each extracted viewpoint.

For Research Problem 3, which sought to determine the level of students' awareness of solid waste management conditions depicted in the photographs, the average rank score was computed for each photograph. The factor scores assigned to each photograph across the seven extracted factors were summed and divided by the total number of factors to obtain the mean rank score. The resulting average scores were interpreted using a descriptive awareness scale ranging from Very High Preference/Strong Agreement to Very Low Preference/Strong Disagreement. The results were presented in a tabular format containing the descriptions of the depicted by the pictures of the school environmental conditions, average rank scores, and corresponding interpretation levels. This presentation facilitated the

identification of environmental conditions that students most readily recognized and those that received relatively lower levels of awareness.

IV. RESULTS AND DISCUSSION

This chapter presents the findings of the study and the corresponding discussions based on the analysis of the Q-sort data gathered from the respondents.

- *The Underlying Patterns of Students' Perception Regarding Solid Waste Management in School Campus Environmental Conditions Depicted in Selected Photographs in Terms of*

Table 1 The Rotated Factor Matrix, Explained Variance and Dominant Q-Sorts Regarding Solid Waste Classification and Management Among the Respondents

Factor	Explained Variance (%)	Dominant Q-Sorts (Highest Loadings)	Description of Shared Viewpoint
Factor 1	33.72 %	R23 (0.949), R58 (0.864), R60 (0.846), R3 (0.841), R8 (0.841)	Dominant viewpoint representing the largest group of respondents with a common understanding of solid waste classification and environmental awareness.
Factor 2	12.38 %	R14 (0.811), R20 (0.811), R46 (0.810), R15 (0.620), R39 (0.581)	Perspective characterized by an alternative interpretation of waste materials, reflecting differences in waste recognition and sorting preferences.
Factor 3	18.22 %	R12 (0.813), R7 (0.776), R11 (0.776), R50 (0.742), R13 (0.675)	Represents respondents who share a distinct viewpoint regarding waste categorization and environmental significance of waste items.
Factor 4	6.97	R57 (0.743), R30 (0.558), R54 (0.555), R17 (0.510), R6 (0.501)	Reflects a smaller group emphasizing characteristics of waste materials when sorting photographs.
Factor 5	5.24	R35 (0.836), R53 (0.671), R56 (0.563), R13 (0.485), R54 (0.365)	Indicates a viewpoint focused on specific waste attributes, demonstrating a unique pattern of waste perception.
Factor 6	4.19	R55 (0.819), R33 (0.764), R36 (0.706), R44 (0.524), R54 (0.480)	Represents respondents with a specialized perspective on waste management and classification practices.
Factor 7	4.06	R34 (0.899), R24 (0.852), R27 (0.706), R21 (0.659), R41 (0.655)	Captures a distinct but less prevalent viewpoint emphasizing alternative interpretations of solid waste photographs.

N=60

Table 1 presents the rotated factor matrix of the sorted solid waste photographs, showing the factor loadings of the 60 respondents (Q-sorts) across the seven extracted factors. In Q methodology, factor loadings represent the degree to which an individual's sorting pattern is associated with a particular factor or shared viewpoint. The seven extracted factors collectively represent distinct perspectives regarding solid waste classification, management, and environmental awareness among the respondents. The extracted factors accounted for varying proportions of the total variance, indicating the relative strength and prevalence of each viewpoint within the study population. Similar findings were reported by Amoah and Addoah (2021), who emphasized that students' waste management perceptions are influenced by environmental awareness, institutional practices, and personal experiences with waste handling.

Among the seven factors, Factor 1 emerged as the most dominant, explaining 33.72% of the total variance. Several respondents exhibited strong positive loadings on this factor, including R23 (0.9486), R58 (0.8643), R60 (0.8458), R3 (0.8414), and R8 (0.8414). The prominence of Factor 1 suggests that a considerable proportion of respondents shared a common understanding and perception regarding the sorting of solid waste photographs. This dominant viewpoint likely reflects a strong consensus on waste recognition and classification practices, indicating that many respondents possess similar environmental awareness and waste management perspectives. This finding supports the study of Knickmeyer (2023), which reported that environmental knowledge and awareness contribute significantly to individuals' ability to recognize appropriate waste management practices. The study emphasized that awareness programs improve waste identification skills and encourage responsible disposal behaviors among students.

The second most influential viewpoint was Factor 3, accounting for 18.22% of the total variance. High-loading respondents such as R51 (-0.8851), R12 (0.8126), R7 (0.7761), R11 (0.7761), and R50 (0.7420) demonstrated a distinct pattern of responses. The emergence of this factor indicates the existence of another substantial group of participants who viewed and categorized the waste photographs differently from those represented in Factor 1. Such variation suggests that while respondents may share general knowledge about waste management, differences exist in how specific waste materials are perceived or prioritized. The presence of different interpretations aligns with the findings of Zhang et al. (2021), who explained that waste perception is affected by individuals' previous experiences, environmental

education, and social context. Their study highlighted that people may recognize waste differently even when exposed to the same environmental situation due to differences in knowledge and attitudes toward sustainability.

Factor 2 explained 12.38% of the total variance and was characterized by strong loadings from respondents such as R14 (0.8108), R20 (0.8108), R46 (0.8097), and R40 (-0.7871). The presence of both positive and negative loadings implies contrasting viewpoints within this factor, reflecting differing interpretations of solid waste photographs among respondents. This factor may represent variations in waste identification influenced by prior experiences, environmental exposure, or educational background.

The remaining factors accounted for smaller yet meaningful portions of the variance. Factor 4 explained 6.97%, with notable loadings from R57 (0.7430), R30 (0.5576), and R54 (0.5553). Factor 5 accounted for 5.24%, highlighted by strong loadings from R35 (0.8360), R53 (0.6709), and R56 (0.5633). Factor 6 explained 4.19%, with R55 (0.8194), R33 (0.7641), and R22 (-0.8002) demonstrating the strongest associations. Lastly, Factor 7 accounted for 4.06% of the total variance, with substantial loadings from R34 (0.8993), R24 (0.8523), R27 (0.7058), and R59 (-0.6615). Although these factors explain smaller portions of the variance, they reveal unique viewpoints that contribute to a more comprehensive understanding of respondents' perceptions of solid waste.

The emergence of multiple viewpoints supports the usefulness of Q methodology in environmental research because it captures both shared and individual perspectives. According to Zabala et al. (2022), Q methodology is effective in studying complex environmental issues because it identifies patterns of subjective understanding rather than relying only on numerical measurements. In this study, the photographic Q-sort approach revealed that students possess varying interpretations of campus solid waste conditions, demonstrating that waste management awareness involves both knowledge and personal perception.

Overall, the extraction of seven factors demonstrates the diversity of perspectives among respondents regarding solid waste photographs. The dominance of Factor 1, coupled with the substantial contributions of Factors 2 and 3, suggests that while a majority of respondents shared common perceptions, several alternative viewpoints also emerged. These findings indicate that respondents possess varying levels of awareness, interpretation, and understanding of solid waste classification, emphasizing the need for continuous environmental education programs that promote consistent and accurate waste identification and management practices. The factor structure further highlights the complexity of environmental perceptions and underscores the value of Q methodology in uncovering shared and divergent viewpoints within a population.

- *The Highest- and Lowest-Ranked Photographs Across the Extracted Factors, Based on Q-Sort Analysis*

Table 2 Highest-Ranked Photograph Across the Seven Extracted Factors

Factor	Highest-Ranked Photograph	Description of the Depicted Photo	Score
Factor 1	Photo 5	Waste materials temporarily placed near a wash area, indicating improper placement of garbage in a communal facility.	+2
Factor 2	Photo 6	Ecological waste cage or recycling enclosure containing plastic bottles, representing proper segregation and recycling practices.	+2
Factor 3	Photo 1	Overflowing garbage bin with waste scattered around the collection area, indicating poor waste containment and improper disposal practices.	+2
Factor 4	Photo 1	Overflowing garbage bin with waste scattered around the collection area, indicating poor waste containment and improper disposal practices.	+2
Factor 5	Photo 10	Mixed waste piled in the corner of a room, reflecting improper indoor waste storage and poor housekeeping practices.	+2
Factor 6	Photo 10	Mixed waste piled in the corner of a room, reflecting improper indoor waste storage and poor housekeeping practices.	+2
Factor 7	Photo 8	Littered open area with scattered plastic and solid waste on the ground, indicating environmental pollution and poor waste management.	+2

Score	Interpretation
+2	Most representative / most strongly associated with the viewpoint represented by the factor
+1	Moderately representative of the factor's viewpoint
0	Neutral or neither strongly representative nor unrepresentative
-1	Moderately unrepresentative of the factor's viewpoint
-2	Least representative / most strongly rejected by the factor's viewpoint

Table 2 presents the highest-ranked photographs for each of the seven extracted factors from the Q-sort analysis, representing the environmental conditions most strongly associated with the respondents' shared

viewpoints. A score of +2 indicates that the photograph was considered the most representative of a particular factor, reflecting the dominant perception of respondents who significantly loaded on that viewpoint.

For Factor 1, respondents assigned the highest rank to Photo 5, which depicts waste materials temporarily placed near a wash area. This finding suggests that respondents associated with this factor viewed improper waste placement in communal facilities as a significant solid waste management concern. The prominence of this photograph indicates heightened awareness of how improper disposal practices can affect sanitation and cleanliness in shared spaces. This observation is consistent with Knickmeyer (2023), who explained that visible waste accumulation and improper placement influence individuals' perceptions of environmental quality and contribute to negative attitudes toward waste management conditions. Similarly, Zhang et al. (2021) reported that people often evaluate waste management effectiveness based on visible environmental cues such as cleanliness, waste storage, and disposal arrangements.

For Factor 2, the highest-ranked photograph was Photo 6, showing an ecological waste cage filled with recyclable plastic bottles. This result reflects a viewpoint that values proper waste segregation and recycling practices. Respondents associated with this factor appeared to recognize the importance of organized waste management systems and the role of recycling in reducing environmental pollution. This finding supports the study of Sah et al. (2022), which found that students with stronger environmental awareness were more likely to appreciate recycling facilities and recognize the importance of waste segregation in promoting sustainability. The result also suggests that campus-based environmental structures can positively influence students' perceptions and behaviors regarding waste management.

Both Factors 3 and 4 identified Photo 1 as the most representative image. The photograph depicts an overflowing garbage bin with waste scattered around the collection area. The shared preference for this image suggests that respondents strongly perceived visible waste accumulation and poor waste containment as major indicators of ineffective solid waste management. The convergence of these two factors highlights widespread concern regarding improper garbage disposal and its implications for public health and environmental quality. This finding is supported by Ncube et al. (2022), who emphasized that poorly managed waste collection areas contribute to environmental concerns, unpleasant surroundings, and increased risk of sanitation problems in educational institutions.

For Factors 5 and 6, respondents assigned the highest rank to Photo 10, which shows mixed waste piled in the corner of a room. This finding indicates that respondents associated poor indoor waste storage and housekeeping practices with significant waste management issues. The shared ranking suggests a concern for cleanliness within enclosed environments and an awareness of the potential health and sanitation risks posed by improperly stored waste. According to Amoah and Addoah (2021), environmental awareness among students is influenced by daily exposure to waste conditions, including waste storage practices in learning environments. Poor indoor waste management may affect perceptions of cleanliness, safety, and environmental responsibility.

Meanwhile, Factor 7 ranked Photo 8 highest. The photograph depicts a littered open area with scattered plastic and solid waste on the ground. This viewpoint emphasizes concern over environmental pollution caused by indiscriminate littering. Respondents associated with this factor appeared to view visible litter in public spaces as a critical manifestation of poor waste management and environmental neglect.

Overall, the results reveal that respondents' perceptions of solid waste management were primarily centered on visible indicators of improper waste disposal, such as overflowing garbage bins, littered surroundings, improperly stored waste, and waste accumulation in communal areas. At the same time, the emergence of the recycling enclosure as the highest-ranked photograph in Factor 2 demonstrates that some respondents also recognized positive waste management practices. These findings suggest that respondents possess diverse yet complementary perspectives regarding solid waste management, encompassing both the identification of environmental problems and the appreciation of appropriate waste disposal and recycling behaviors.

The identification of the ecological waste cage as the highest-ranked photograph in Factor 2 also reveals that some respondents recognized positive waste management practices, particularly segregation and recycling initiatives. This supports the idea that environmental education and proper waste management facilities contribute to improved sustainability awareness among students. According to Zabala et al. (2022), Q methodology is particularly useful in environmental studies because it reveals diverse subjective viewpoints, allowing researchers to understand both shared concerns and differing interpretations within a population.

Table 3 Lowest-Ranked Photograph Across the Seven Extracted Factors

Factor	Lowest-Ranked Photograph	Description of the Depicted Photo	Score
Factor 1	Photo 3	Solid waste trapped in a drainage canal, potentially obstructing water flow and contributing to flooding and sanitation issues.	-2
Factor 2	Photo 4	Individual picking up litter from the ground, demonstrating proper waste disposal behavior and environmental responsibility.	-2
Factor 3	Photo 9	Solid waste accumulated along a staircase, creating an unsanitary environment and possible safety hazards.	-2
Factor 4	Photo 7	Improperly discarded containers and waste materials near a wall, showing poor disposal habits and potential health risks.	-2
Factor 5	Photo 4	Individual picking up litter from the ground, demonstrating proper waste disposal behavior and environmental responsibility.	-2
Factor 6	Photo 7	Improperly discarded containers and waste materials near a wall, showing poor disposal habits and potential health risks.	-2
Factor 7	Photo 5	Waste materials temporarily placed near a wash area, indicating improper placement of garbage in a communal facility.	-2

Score	Interpretation
+2	Most representative / most strongly associated with the viewpoint represented by the factor
+1	Moderately representative of the factor's viewpoint
0	Neutral or neither strongly representative nor unrepresentative
-1	Moderately unrepresentative of the factor's viewpoint
-2	Least representative / most strongly rejected by the factor's viewpoint

Table 3 presents the lowest-ranked photographs for each of the seven extracted factors. A score of -2 indicates that the photograph was considered the least representative of the respondents' shared viewpoint within a particular factor. These photographs represent environmental conditions or waste management practices that respondents associated with a factor viewed as less significant, less relevant, or inconsistent with their dominant perception of solid waste management.

For Factor 1, respondents assigned the lowest rank to Photo 3, which depicts solid waste trapped in a drainage canal. This finding suggests that respondents associated with this factor considered drainage-related waste accumulation less representative of their primary concerns compared to other waste management issues. Their viewpoint may have focused more on waste placement and disposal practices within communal spaces rather than waste obstructing waterways. This is consistent with Zhang et al. (2021), who reported that public perceptions of waste problems are strongly influenced by the visibility and immediate environmental impact of waste conditions.

For Factors 2 and 5, the lowest-ranked photograph was Photo 4, showing an individual picking up litter from the ground. Since the image portrays responsible environmental behavior rather than improper waste disposal, respondents associated with these factors may have perceived it as less representative of solid waste management problems. This result suggests that these factors were primarily concerned with identifying waste-related issues rather than positive environmental actions.

For Factor 3, respondents assigned the lowest rank to Photo 9, which depicts waste accumulated along a staircase. Although the photograph illustrates poor waste management, respondents associated with this factor considered it less representative than other environmental conditions such as overflowing garbage bins or visible waste accumulation. This finding indicates that they may have prioritized more severe or highly visible waste management concerns.

For Factors 4 and 6, Photo 7 received the lowest ranking. The photograph shows improperly discarded containers and waste materials near a wall. Respondents associated with these viewpoints may have viewed this condition as a less critical indicator of waste management problems compared to other forms of waste accumulation, such as overflowing bins or littered open spaces. This suggests a tendency to prioritize more extensive or obvious manifestations of environmental neglect.

For Factor 7, respondents assigned the lowest rank to Photo 5, which depicts waste materials temporarily placed near a wash area. This result indicates that respondents associated with this factor considered temporary waste placement less representative of their perception of solid waste issues. Instead, as reflected in their highest-ranked photograph, they appeared to place greater emphasis on visible environmental pollution and widespread littering in open areas.

Overall, the lowest-ranked photographs reveal the environmental conditions that respondents considered least aligned with their respective viewpoints on solid waste management. Notably, the photograph depicting responsible environmental behavior (Photo 4) was consistently ranked lowest by two factors, suggesting that respondents were more focused on identifying waste-related problems than highlighting corrective actions. The results further demonstrate that perceptions of solid waste management vary across viewpoints, with respondents assigning differing levels of importance to specific waste conditions. These findings complement the highest-ranked

photographs by providing a clearer understanding of the issues.

The findings further demonstrate the usefulness of Q methodology in identifying variations in environmental perceptions. As explained by Zabala et al. (2022), Q methodology allows researchers to uncover shared subjective viewpoints and differences in how individuals interpret environmental issues. In this study, the lowest-ranked photographs complemented the highest-ranked results by showing not only what respondents considered important but also what conditions they viewed as less representative of campus solid waste management concerns.

- *The Level of Students' Awareness of Solid Waste Management in School Campus Environmental Conditions Depicted in Selected Photographs Based on Q-Sort Average Rank Scores*

Table 4 Level of Students' Awareness of Solid Waste Management in School Campus Environmental Conditions Depicted in Selected Photographs Based on Q-Sort Average Rank Scores

Photographs	Description of the Depicted Photo	Average Rank Score	Interpretation Level
Photo 1	Overflowing garbage bin with waste scattered around the collection area, indicating poor waste containment and improper disposal practices.	0.7142	High awareness
Photo 2	Dumped and unsegregated garbage in bins and bags placed in pole areas	-0.1428	Slightly below neutral
Photo 3	Solid waste trapped in a drainage canal, potentially obstructing water flow and contributing to flooding and sanitation issues.	-0.1428	Slightly below neutral
Photo 4	Individual picking up litter from the ground, demonstrating proper waste disposal behavior and environmental responsibility.	-0.7142	Very low awareness
Photo 5	Waste materials temporarily placed near a wash area, indicating improper placement of garbage in a communal facility.	-0.2857	Low awareness
Photo 6	Ecological waste cage or recycling enclosure containing plastic bottles, representing proper segregation and recycling practices.	0.1428	Slightly above neutral
Photo 7	Improperly discarded containers and waste materials near a wall, showing poor disposal habits and potential health risks.	-0.4285	Low awareness
Photo 8	Littered open area with scattered plastic and solid waste on the ground, indicating environmental pollution and poor waste management.	0.8571	Highest awareness
Photo 9	Solid waste accumulated along a staircase, creating an unsanitary environment and possible safety hazards.	-0.4285	Low awareness
Photo 10	Mixed waste piled in the corner of a room, reflecting improper indoor waste storage and poor housekeeping practices.	0.5710	High awareness

Range of Scores	Interpretation Level	Meaning in Q-Sort Context
0.60 to 0.90	Very High Awareness	Very High Preference / Strong Agreement
0.30 to 0.59	High Awareness	High Preference / Agreement
0.01 to 0.29	Slightly Above Neutral	Slightly Above Neutral
0.00	Neutral	Neutral
-0.01 to -0.29	Slightly Below Neutral	Slightly Below Neutral
-0.30 to -0.59	Low Awareness	Low Preference / Disagreement
-0.60 to -0.90	Very Low Awareness	Very Low Preference / Strong Disagreement

Table 4 presents the average rank scores of the ten selected photographs depicting various solid waste management conditions within the school campus. The average rank scores were obtained by aggregating the factor scores assigned to each photograph across the seven extracted factors and dividing the total by the number of factors. These scores were used to determine the level of students' awareness regarding the environmental conditions represented in each photograph. Higher positive scores indicate greater awareness and recognition of the waste management issue depicted, while lower negative scores indicate lower awareness and reduced salience among respondents.

A closer examination of the table reveals that Photo 8, which depicts a littered open area with scattered plastic

and solid waste, obtained the highest average rank score of 0.8571, corresponding to the Highest Awareness level. This was followed by Photo 1, showing an overflowing garbage bin with scattered waste, which garnered an average rank score of 0.7142 and was interpreted as High Awareness. Similarly, Photo 10, depicting mixed waste piled in the corner of a room, obtained an average rank score of 0.5710, indicating High Awareness. Meanwhile, Photo 6, which portrays an ecological waste cage containing recyclable plastic bottles, received a score of 0.1428, interpreted as Slightly Above Neutral. On the other hand, Photo 4, showing an individual picking up litter from the ground, recorded the lowest average rank score of -0.7142, corresponding to Very Low Awareness. Other photographs that received low awareness ratings included Photo 7 and Photo 9 (-0.4285), as well as Photo 5 (-0.2857). Additionally, Photos 2 and 3 obtained scores of -0.1428, indicating a Slightly Below Neutral level of awareness.

The findings suggest that students exhibited greater awareness of highly visible and easily recognizable manifestations of poor waste management, particularly conditions involving littering, overflowing garbage bins, and improper waste accumulation. The highest awareness rating assigned to Photo 8 indicates that respondents strongly recognized open littering and environmental pollution as significant waste management concerns. Likewise, the high ratings for Photos 1 and 10 demonstrate that students readily identified visible waste accumulation and improper waste storage as indicators of poor environmental stewardship. Conversely, photographs depicting corrective actions or less conspicuous waste management issues, such as an individual picking up litter (Photo 4) or waste trapped in drainage canals (Photo 3), received relatively lower awareness ratings. This pattern suggests that students are more likely to notice and associate visible waste-related problems with environmental concerns than they are to recognize positive waste management behaviors or indirect environmental consequences of improper disposal practices.

These findings imply that students' awareness of solid waste management is largely influenced by the visibility and immediacy of environmental conditions. While respondents demonstrated a strong ability to recognize obvious signs of environmental degradation, there appears to be a need to strengthen awareness regarding less visible waste management issues and positive environmental practices. School-based environmental education programs may therefore focus not only on identifying waste-related problems but also on promoting appreciation of responsible waste disposal behaviors, waste segregation practices, recycling initiatives, and the broader environmental impacts of improper waste management. Enhancing students' understanding of both preventive and corrective waste management measures may contribute to the development of more comprehensive environmental awareness and responsible waste management behaviors within the school community.

This pattern is supported by Zabala et al. (2022), who explained that Q methodology is valuable in environmental research because it reveals how individuals prioritize and interpret environmental issues based on their subjective viewpoints. The differences in ranking demonstrate that respondents do not perceive all waste conditions equally; instead, their judgments are influenced by visibility, familiarity, and perceived environmental impact.

V. CONCLUSIONS

This study explored the underlying patterns of students' perceptions regarding solid waste management in school campus environmental conditions through the application of Q methodology.

The findings revealed that students possess diverse yet interconnected viewpoints concerning waste management practices, as evidenced by the seven extracted factors that collectively explained 84.77% of the total variance. Among these factors, Factor 1 accounted for the largest proportion of variance (33.72%), indicating a dominant viewpoint shared by a substantial number of respondents. The extracted factors and their corresponding dominant Q-sort loadings demonstrated that students differ in the environmental conditions they prioritize when evaluating solid waste management issues within the school campus.

The study further identified the environmental conditions most and least associated with the seven extracted viewpoints. The highest-ranked photographs revealed that students strongly recognized visible manifestations of waste management concerns, including improper waste placement in communal areas, overflowing garbage bins, littered surroundings, and improper indoor waste storage. In contrast, the lowest-ranked photographs indicated that respondents placed less emphasis on certain waste conditions such as waste trapped in drainage systems, waste accumulation along stairways, and photographs depicting positive environmental behaviors. These findings suggest that students' perceptions are influenced primarily by the visibility and immediacy of waste-related conditions within their surroundings.

Moreover, the analysis of average rank scores demonstrated varying levels of awareness regarding the environmental conditions depicted in the photographs. The highest awareness was observed for Photo 8 ($M = 0.8571$), which portrayed a littered open area with scattered plastic and solid waste, followed by Photo 1 ($M = 0.7142$), depicting an overflowing garbage bin, and Photo 10 ($M = 0.5710$), showing improper indoor waste storage. Conversely, the lowest awareness was recorded for Photo 4 ($M = -0.7142$), which depicted an individual picking up litter. These results indicate that students are more aware of visible environmental problems than of positive waste management practices and preventive environmental actions.

Overall, the study concludes that students possess a relatively strong awareness of visible solid waste management issues within the school environment, but exhibit lower recognition of positive environmental behaviors and less conspicuous waste-related concerns. The findings underscore the importance of strengthening environmental education programs that not only highlight the consequences of improper waste disposal but also promote responsible waste management practices, waste segregation, recycling initiatives, and active environmental stewardship. Through sustained awareness campaigns and school-based interventions, students can develop a more comprehensive understanding of solid waste management and contribute more effectively to maintaining a clean, healthy, and sustainable school environment.

RECOMMENDATIONS

Based on the findings of the study, the following are recommended:

- Prioritize awareness campaigns on visible waste accumulation and littering hotspots within the school campus. Since Photo 8 (littered open area with scattered plastic and solid waste) obtained the highest awareness score (M = 0.8571) and Photo 1 (overflowing garbage bin) recorded a high awareness score (M = 0.7142), students readily recognize these environmental concerns. School administrators may capitalize on this existing awareness by implementing targeted campaigns, clean-up drives, and monitoring programs in areas prone to littering and waste accumulation to further reinforce proper waste disposal behaviors.
- Strengthen environmental education on proper waste segregation and recycling practices. Although Photo 6, which depicts an ecological waste cage and recycling practice, received a positive average rank score (M = 0.1428), it was only interpreted as slightly above neutral. This suggests that students recognize recycling practices but may not fully appreciate their importance. Therefore, regular orientations, demonstrations, and school-wide recycling initiatives should be conducted to enhance students' understanding and participation in waste segregation and recycling programs.
- Promote positive environmental behaviors through recognition and participation programs. The finding that Photo 4, showing an individual picking up litter, received the lowest awareness score (M = -0.7142) indicates that students may place less importance on corrective environmental actions than on visible waste problems. The school may establish environmental stewardship programs, recognition systems, and student volunteer activities that encourage and reward responsible waste management behaviors.
- Improve waste management supervision in communal and indoor areas. The highest-ranked photographs across several factors included Photo 5 (improper waste placement near a wash area) and Photo 10 (mixed waste piled inside a room), indicating that students perceive these conditions as significant waste management concerns. School authorities should therefore strengthen waste monitoring and collection systems in wash areas, classrooms, and other communal spaces to prevent improper waste accumulation and maintain campus cleanliness.
- Develop comprehensive environmental awareness programs that address less recognized waste management issues. The relatively low awareness scores for Photo 3 (waste trapped in drainage canals), Photo 7 (improperly discarded waste near walls), and Photo 9 (waste accumulation along stairways) suggest that students may overlook environmental conditions with indirect or less visible impacts. Environmental education programs should therefore emphasize the consequences of these issues, including flooding, sanitation problems, health risks, and environmental degradation, to foster a more holistic understanding of solid waste management.

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