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Assessing Sustainable Solid Waste Management Practices in Selected Senior High Schools in the New Juabeng North Municipality, Ghana

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Abstract

This study assessed sustainable solid waste management (SSWM) practices in selected senior high schools in the New Juabeng North Municipality, Ghana, using a descriptive survey design. Data were collected via observation checklists and structured questionnaires administered to 360 students from four selected schools through purposive and simple random sampling. A waste characterization study was conducted across the school compound, including dining halls, dormitories, classrooms, and common areas, over a four-week period. The composition was determined based on the observed frequency of waste items, tallied by two trained researchers using a standardized checklist, following a modified ASTM Committee D-34 on Waste Management protocol for visual characterization. Results indicated that plastics (37%), paper (25%), and packaging materials dominated the waste stream, reflecting student consumption and institutional activities. While students exhibited high awareness (mean index = 2.64) and positive attitudes (mean index = 2.67) toward SSWM, their actual practices were notably low (mean index = 1.67), particularly in waste segregation, recycling, and composting. Correlation analysis revealed strong positive association between awareness and attitudes ($\rho = 0.64$, $p < 0.001$, 95% CI [0.57, 0.70]) and between attitudes and practices ($\rho = 0.71$, $p < 0.001$, 95% CI [0.65, 0.76]), but a weaker link between awareness and practices ($\rho = 0.58$, $p < 0.001$, 95% CI [0.50, 0.65]). This underscores that positive attitudes are a more critical factor associated with behavior than awareness alone.

The study concludes that bridging the knowledge-practice gap requires integrated interventions beyond awareness campaigns. We recommend that school authorities, in collaboration with municipal assemblies, establish functional recycling units, provide adequate waste segregation infrastructure, and integrate practical waste management activities into curricular and co-curricular activities through environmental clubs and school-based campaigns.

Keywords

Sustainable Solid Waste Management, Knowledge-Attitude-Practice (KAP) Model, Senior High Schools, Waste Segregation, School-Based Waste Management, Awareness-Practice Gap

1. Introduction

Solid waste management remains one of the most critical environmental challenges confronting both developing and developed nations. As global population increases and consumption patterns shift, the volume of waste produced continues to rise at an alarming rate. In 2015, the world generated approximately 2 billion metric tons of solid waste, a figure projected to rise to 3.4 billion metric tons by 2050, with low-income countries expected to experience the most dramatic increases (Valavanidis, 2023). Managing this growing waste stream requires coherent systems that will ensure proper collection, transportation, treatment, and disposal of waste, supported by strong regulatory frameworks, adequate infrastructure, and informed public participation (Jayaraman, Tripathi, & Ramakrishnan, 2026). Waste management therefore encompasses not only technical processes but also behavioral, educational, and organizational components necessary for maintaining a healthy environment (Al-Fakih & Almarani, 2025).

Solid waste management remains a persistent challenge in many developing countries, including Ghana due to factors such as inadequate infrastructure, poor planning, rapid urbanisation, limited public awareness, and weak enforcement of sanitation laws (Zohoori & Ghani, 2017). These challenges have resulted in widespread littering, indiscriminate dumping of waste, clogged drains, pollution of water bodies, and increased incidence of sanitation-related diseases. Urban centers are particularly affected, as the growing population exerts pressure on already strained waste management facilities (Barimah et al., 2025). Schools, especially senior high schools are not exempt from these challenges. As spaces that host large numbers of students daily, they generate significant quantities of solid waste, yet many lack organized systems for segregation, recycling, or safe disposal (Boateng, Boakye-Ansah, Baah, Aboagye, & Kyeremeh, 2023). This undermines the school environment and exposes students and staff to potential health risks.

These waste management challenges are increasingly evident in the New Juabeng North Municipality of the Eastern Region of Ghana. Although solid waste bins and designated dumpsites exist in most senior high schools, observations show

that students frequently engage in improper disposal behaviors, including littering, open dumping, and poor handling of non-biodegradable materials. Such behaviors result in serious environmental problems, including mosquito breeding in discarded tins, blockage of drains, contamination of the environment, and general deterioration of sanitation conditions (Abdullah et al., 2024).

Prior studies have highlighted the importance of awareness, attitudes, and practices in influencing sustainable waste management, yet there is limited empirical evidence focusing specifically on students within this municipality (Owojori, Mulaudzi, & Edokpayi, 2022). This lack of localized research creates a gap in understanding how students perceive and engage in Sustainable Solid Waste Management (SSWM) within their school environment. The purpose of the study was to assess sustainable solid waste management practices in selected senior high schools in the New Juabeng North Municipality. Specifically, the study examined the types of solid waste generated, students' awareness of sustainable waste management, their disposal practices, and their attitudes toward sustainable management of solid waste within the school environment.

2. Literature Review

2.1. Solid Waste Management

Solid waste management (SWM) encompasses the systematic control of the generation, storage, collection, transport, processing, and disposal of solid waste (Pires, Martinho, Rodrigues, & Gomes, 2019). Effective SWM is important for maintaining public health, environmental integrity, and aesthetic values, especially within educational institutions such as senior high schools. The increasing student populations and diverse activities in these schools contribute to significant waste generation, necessitating comprehensive management strategies. Studies focusing on senior high schools in Ghana have revealed that the predominant types of waste generated include organic materials, plastics, paper, and metals. For instance, research conducted in the Ashanti Region identified that organic waste constituted approximately 70.91% of the total waste, followed by plastics at 11.24%, metals at 5.64%, textiles at 4.67%, and paper at 2.13% (Anyine, 2022). This composition emphasizes the necessity for targeted waste management practices that address the specific waste streams prevalent in these educational settings.

The rate of waste generation in senior high schools varies, with per capita daily generation rates ranging from 0.02 to 0.13 kg, averaging around 0.056 kg per student per day (Safo-Adu & Owusu-Adzorah, 2023). Factors influencing these rates include the school's population size, the presence of boarding facilities, and the consumption patterns of students. Notably, schools with larger student populations tend to have lower per capita waste generation rates, possibly due to economies of scale in resource utilization and waste production. Despite the implementation of waste management systems in some schools, challenges persist. A comparative analysis between urban and rural senior high schools in the Ashanti Region revealed that while both had waste management practices in place, they faced

distinct challenges. Urban schools struggled with inadequate waste collection routines, whereas rural schools contended with poor student attitudes toward waste management (Stromquist, 2005). A common issue across both settings was the lack of sufficient resources for effective waste management.

The implications of inadequate SWM in schools are profound, affecting environmental quality and public health. For instance, in the Wa Municipality, poor waste disposal practices have been linked to unsanitary conditions, leading to disease outbreaks such as cholera and other diarrheal diseases (Palamuleni, 2002). The absence of proper waste segregation, insufficient disposal facilities, and irregular waste collection exacerbate these issues, highlighting the need for comprehensive waste management strategies. Several recommendations have been proposed to address these challenges. Encouraging composting of organic waste can significantly reduce the volume of waste requiring disposal and provide a valuable resource for agricultural activities. Implementing source separation by providing designated bins for different waste streams can facilitate recycling and reduce environmental pollution (Moh, 2017).

Additionally, integrating environmental sanitation education into school curricula and forming environmental clubs can enhance students' awareness and participation in sustainable waste management practices. The role of external stakeholders, including municipal assemblies and waste management companies, is important for regular waste collection services, the provision of adequate waste disposal facilities, and the monitoring of waste management practices. This support can help schools maintain clean and healthy environments (Mensah, 2019). Collaborations between schools and these entities can lead to more efficient and sustainable waste management systems.

2.1.1. Composition of Solid Waste

Solid waste, commonly referred to as refuse or garbage, includes a wide range of materials that are discarded after use and are no longer considered valuable by the user (Hannan et al., 2015). These waste materials may be generated from residential, commercial, industrial, or institutional sources, with senior high schools forming a significant portion of the institutional category. Solid waste in the school environment reflects the variety of daily human activities carried out within educational settings, such as eating, learning, maintenance, sanitation, and administrative tasks (Mpuangnan, Mhlongo, & Govender, 2023). As education institutions grow in student population and facilities, the volume and complexity of solid waste generated also increases. In the context of senior high schools, the composition of solid waste generated are diverse, ranging from biodegradable organic waste to non-biodegradable items. Organic waste in schools typically includes leftover food, fruit peels, vegetable scraps, and other forms of kitchen waste produced from school canteens or food vendors (Derqui, Fernandez, & Fayos, 2018). These wastes are often produced in large quantities, especially in boarding schools where meals are prepared and served regularly.

Another category of solid waste found in schools is paper waste. This includes

used notebooks, examination papers, textbooks, administrative documents, packaging materials, and other forms of paper-based products. The educational process heavily relies on printed materials, contributing significantly to paper waste generation (Smyth, Fredeen, & Booth, 2010). Despite the increased use of digital technologies in teaching and learning, paper remains a core instructional material in most schools in developing countries. This trend has been confirmed in studies indicating that paper waste makes up to 30% - 40% of the total waste stream generated in schools (Gallardo et al., 2016). Additionally, plastic waste is also highly prevalent in school environments. As students and staff commonly use plastic bags, water sachets, beverage bottles, food wrappers, and other packaging materials which are often discarded. These materials are non-biodegradable and pose a long-term threat to the environment. In a study conducted across selected public schools in Nigeria, plastic waste constituted over 35% of the waste generated by students (Uzodianya, 2026). The increasing dependency on packaged foods and bottled water in senior high schools contributes significantly to the rise in plastic waste.

Furthermore, e-waste is an emerging category of solid waste in senior high schools, resulting from the growing use of electronic devices for administrative, instructional, and recreational purposes. E-waste including broken or obsolete electronic gadgets such as calculators, projectors, printers, computer components, and mobile phones (Kumar et al., 2024). These materials, though less frequently generated compared to paper and plastic, require careful handling and disposal due to the hazardous substances they contain. Improper disposal of e-waste can result in environmental contamination and health issues for school occupants. Metal and glass waste are also present in schools, though in relatively smaller quantities. Metal waste arises from damaged furniture, cans, and electrical fittings, while glass waste including broken windows, laboratory apparatus, and beverage containers. These waste forms, though less frequent, pose the risk of injury and require special attention in waste handling procedures (Ho & Chen, 2018). Laboratory-based schools are particularly prone to generating glass and chemical-related solid waste due to the nature of science practical lessons.

Textile waste is another form of solid waste that has been identified in schools, particularly in settings where uniforms, dormitory bedding, curtains, and sportswear are used. Worn-out clothing, torn mattresses, and discarded fabrics from school sewing activities constitute textile waste (Wojnowska-Baryła et al., 2024). Though generated less frequently, these wastes occupy large volumes of space and are often difficult to manage due to their bulkiness. Sanitary waste including used sanitary pads, tissues, and diapers are increasingly being generated in co-educational and boarding schools. These materials, when not well-managed, pose significant health risks and cause discomfort, especially in female dormitories and washrooms. The increase in female enrolment in senior high schools has led to a corresponding rise in sanitary waste and their management is often overlooked due to cultural taboos and lack of adequate facilities for safe disposal (Gbogbo et

al., 2025).

2.1.2. Awareness of Sustainable Solid Waste Management

Awareness encompasses the understanding, attitudes, and behaviors related to waste generation, segregation, recycling, and disposal in an environmentally responsible manner (Almulhim & Abubakar, 2021). Several studies have highlighted the pivotal role of awareness in promoting sustainable solid waste management practices. In a study conducted in Kawangware, Nairobi County, by Morara, Djongana, & Awuor (2023) found that mass media campaigns significantly influenced public awareness of proper solid waste management. The study revealed that strategic communication through various media channels effectively educated residents about waste management practices, leading to improved behaviors. Similarly, in Dodoma City, Tanzania, research by Mushi (2024) indicated that a majority of market vendors lacked awareness of sustainable SWM measures, underscoring the need for targeted educational interventions.

Educational institutions play an important role in fostering awareness among students, who are instrumental in shaping future environmental practices. Kyere, Addaney, & Akudugu (2019) investigated the awareness levels of basic school pupils in Dormaa Municipality, Ghana, and found that early exposure to waste management education through class discussions significantly enhanced students' understanding of proper waste practices. However, the study also noted that while awareness levels were high, translating this knowledge into consistent practice remained a challenge. The gap between awareness and actual practice is a recurring theme in SWM literature. A study by Liao & Li (2019) examining students' attitudes towards municipal solid waste management revealed that although awareness levels were adequate, especially among high school students, the adoption of appropriate practices was lacking. This discrepancy suggests that awareness alone is insufficient; there must be concerted efforts to encourage behavioral change and active participation in waste management initiatives.

In Malaysia, Swesi et al. (2019) explored the knowledge and practices of sustainable SWM among rural communities. The study found that initial knowledge levels were low; however, after educational briefings and practical demonstrations on composting, there was a significant improvement in both awareness and practice. This finding emphasizes the effectiveness of hands-on, community-based education in enhancing sustainable waste management practices. Despite the positive outcomes, challenges persist in ensuring widespread awareness and practice of sustainable SWM. In Tehran, a study by Zand, Heir, & Khodaei (2022) revealed that only one-third of residents had appropriate awareness of solid waste management. The study highlighted deficiencies in public education and participation, suggesting that without adequate training and facilities, public engagement in waste management remains limited.

Furthermore, cultural and societal factors influence awareness and practices related to SWM. In Malaysia, a study by Al-Sari' & Haritash (2025) using logistic

regression analysis found that only 37.91% of respondents were aware of solid waste management and environmental care. The study emphasized the need for broad-based awareness campaigns that consider cultural values and individual responsibilities to enhance environmental sustainability. Bridging the gap between awareness and action requires comprehensive strategies that encompass education, policy implementation, and community engagement. A study by Badawi et al. (2024) utilized the theory of planned behavior to analyses the relationship between awareness and actual waste management practices. The study found that awareness of specific municipal solid waste management policies was the strongest predictor of positive attitudes and behaviors, indicating that policy awareness can significantly influence individual actions.

Twumasi (2017) conducted a study in Ghana, specifically in the Winneba Municipality, revealing that while many residents were aware of SWM strategies, there was a significant gap between awareness and actual practice. The study emphasized the need for increased social commitment to enhance participation in waste management activities. Another study conducted in Malaysia by Salleh et al. (2020) and it explored the knowledge and practices of sustainable SWM among rural communities. The study found that initial knowledge levels were low; however, after educational briefings and practical demonstrations on composting, there was a significant improvement in both awareness and practice. The role of formal education in raising awareness is further emphasized in a review by Debrah et al. (2021), which analyzed environmental knowledge, awareness, attitudes, and practice studies on SWM from 2010 to 2019 in developing countries. The review highlighted that while students at both secondary and tertiary levels had positive environmental attitudes and high awareness of environmental issues, there was a lack of practical education to guide students in applying SWM practices.

Moreover, a study in Northern Malawi by Kamanga et al. (2024) emphasize the importance of public awareness campaigns and programs in enhancing public participation in SWM. The study suggested that incentives for recycling and waste reduction, along with improved communication and engagement of residents, can significantly increase public participation in waste management. According to Anokye et al. (2025), the awareness of sustainable solid waste management has improved in various regions, but translating this awareness into consistent and effective practices remains a challenge. Comprehensive strategies that encompass education, policy implementation, and community engagement are essential to bridge the gap between awareness and action.

2.1.3. Practices Towards Sustainable Solid Waste Management

Sustainable solid waste management remains a global and local issue, especially in Ghana where poor waste management practices continue to jeopardize public health and environmental quality (Barimah et al., 2025). The practices of individuals and institutions toward sustainable waste management determine the effectiveness and sustainability of waste interventions. These practices encompass how individuals generate, segregate, store, transport, recycle, and dispose of waste ma-

terials. In recent times, there has been a noticeable shift toward promoting sustainable practices, particularly in urban centers, however, several studies have shown that in many regions, including parts of Africa, sustainable waste management practices remain insufficient (Kusi-Appiah, Murphy, & Liu, 2025).

Several studies have emphasized that sustainable solid waste management depends largely on the practices adopted by people in their daily routines. For instance, the study conducted by Sarfo-Mensah et al. (2019). In Kumasi, Ghana revealed that while some residents showed commitment to basic waste sorting and recycling, the majority still depended on communal bins without separating waste, thereby complicating the recycling process. This finding is supported by Gyimah et al. (2021), who investigated households in Cape Coast and observed that although most individuals were aware of the concept of sustainability in waste disposal, they lacked the facilities and institutional support to implement best practices. The research further noted that ineffective collection systems and poor public attitudes contributed to the indiscriminate dumping and burning of waste. Empirical studies have also highlighted the strong relationship between awareness and sustainable practices. Knowledge and awareness campaigns have often resulted in improved waste behaviors in different communities. For instance, Larbi et al. (2024), conducted a study among tertiary students in the Ashanti Region and found a significant correlation between their awareness levels and their participation in recycling programs. Those who had been exposed to environmental education programs were more likely to practice waste segregation and proper disposal. Similarly, Essien and Spocter (2023) noted that among market vendors in Accra, those who participated in community sensitization programs were better informed about the environmental impacts of improper waste disposal and were more likely to adopt sustainable practices.

It has also been established that practices toward sustainable waste management are influenced by socio-cultural norms, infrastructure, and institutional frameworks. Research by Omole et al., (2016) in Nigeria underscored that even when people are aware of proper waste management methods, they may not adopt them due to deeply rooted cultural practices or the absence of basic facilities such as bins and recycling centers. The same study showed that in areas where municipal authorities were consistent in waste collection and community engagement, residents were more responsive and committed to sustainable practices. This aligns with findings from Njau, Onyango and Itegi (2024), who reported that a structured waste management system coupled with education created a favorable environment for better waste handling practices in schools and households across Nairobi.

Conversely, several studies have also assessed the effectiveness of waste management initiatives in schools, particularly in the promotion of sustainable waste management practices among students. According to Henyo et al. (2024), schools serve as a microcosm of society where students' exposure to waste management education significantly affects their behavior at home and in their communities.

Their study, which focused on senior high schools in the Eastern Region of Ghana, found that students who received consistent instruction and participated in environmental clubs demonstrated better waste management habits compared to those who did not. In a similar vein, Larbi et al., (2024) highlighted that schools that collaborated with local waste management authorities and integrated practical waste handling activities into their curricula achieved more sustainable waste outcomes. A study by Duna (2015) surveyed residents in urban and peri-urban areas in the Greater Accra Region and found that although the term "sustainability" was familiar to most participants, many lacked comprehensive knowledge about its implications in the context of waste management. The study emphasized the need for targeted awareness campaigns that go beyond basic information dissemination and include demonstrations, community participation, and school-based interventions.

Multiple researchers have identified the media, formal education, and community workshops as the most effective channels for raising awareness. In a study conducted in Uganda by Edodi (2023) discovered that radio and television programs were instrumental in educating the public about the dangers of improper waste disposal and promoting sustainable alternatives such as composting and recycling. Meanwhile, Kofi et al., (2023) in Ghana found that public participation in local government meetings on sanitation issues significantly increased community buy-in and led to better waste management practices. The same study highlighted those informal settlements, which are often excluded from these initiatives, remained hotspots for poor waste management. In the academic context, sustainable practices are often tied to students' exposure to environmental topics. A study by Takyi et al. (2025) found that integrating environmental sustainability into science and social studies curricula led to improved attitudes and practices among junior high school students, therefore it would be appropriate if the environmental sustainability is integrated into the science curricula in the senior high schools in Ghana. They observed that students who engaged in project-based learning on topics such as composting and waste segregation were more proactive in implementing those practices both at school and at home.

Another dimension worth mentioning is the gendered nature of sustainable practices. Recent work by Henyo et al. (2024) indicated that female students and teachers were more likely to engage in and promote sustainable solid waste practices, largely due to their traditional roles in domestic hygiene and their active participation in school-based clubs. This supports earlier findings by Amoah et al. (2023), who argued that sustainability programs need to be inclusive and gender-sensitive to be truly effective. Although, there is a positive effect on the practices of sustainable solid waste management, it is clear that structural barriers such as funding constraints, poor institutional coordination, and lack of infrastructure continue to hinder progress. Osei-Bonsu (2026) stressed the need for government commitment in bridging these gaps through policy implementation and funding of waste programs, especially in schools. The authors suggest that awareness alone

is insufficient without a supportive environment that allows people to act on their knowledge. The literature also suggests that sustainable solid waste management must be a shared responsibility among individuals, institutions, and governments.

Findings from a cross-country comparison by Karabulut & Manga (2025) in Brazil, India, and South Africa indicated that countries that invested in both public education and infrastructure experienced higher compliance with sustainable waste management practices. They also noted that waste management strategies that incorporated community participation yielded more durable and culturally appropriate results. The convergence of education, infrastructure, and policy offers the most promising pathway toward achieving sustainable solid waste management across different sectors of the society (Chareonvong et al., 2025). As literature continues to evolve, there is a clear consensus that behavioral change, driven by awareness and backed by resources, remains central to resolving the waste crisis in many developing contexts.

2.1.4. Attitudes towards Sustainable Solid Waste Management

The success of environmental projects is greatly influenced by attitudes toward sustainable solid waste management, particularly in developing nations like Ghana (Ishawu et al., 2020). The growing difficulties in waste management in recent years have highlighted the necessity of comprehending and influencing public opinion in order to promote sustainable methods. In Ghana, the perspectives of students, educators, and the broader community significantly influence the success of SWM initiatives. Research indicates that while awareness of waste management issues is relatively high, translating this awareness into consistent, sustainable practices remains a challenge. A study by Owusu-Ansah et al., (2022) revealed that a substantial majority of Ghanaians acknowledge the environmental pollution resulting from inadequate waste separation and management. Despite this recognition, only a fraction of the population actively engages in proper waste segregation. This discrepancy suggests that awareness alone does not necessarily lead to behavioral change. Factors such as convenience, accessibility to waste disposal facilities, and ingrained habits play a role in shaping attitudes toward SWM.

The attitudes of students toward waste management in educational settings are influenced by both institutional policies and cultural norms. Henyo et al., (2024) observed that in some Ghanaian senior high schools, sanitation practices are often gendered, with female students predominantly responsible for cleaning activities. This division of labor can impact male students' perceptions of their role in maintaining a clean environment, potentially leading to disengagement from waste management responsibilities. The role of educators is also important in shaping students' attitudes towards SWM. A study by Dalu et al., (2020) highlighted that teachers' awareness of the environmental impacts of plastic waste significantly influenced their commitment to educating students about sustainable practices. When educators prioritize environmental topics and model responsible behavior, students are more likely to adopt similar attitudes and practices.

Community perceptions and behaviors further complicate the landscape of

SWM attitudes. Sarpong-Anane (2015) found that in the Mamobi community of Accra, there is a general disregard for waste management regulations, with residents often engaging in indiscriminate dumping. This behavior reflects a broader societal attitude where waste management is not prioritized, and enforcement of existing laws is weak. Such community norms can influence students' attitudes, especially when school practices do not align with those observed in their neighborhoods. The effectiveness of communication strategies in promoting sustainable waste practices is another factor influencing attitudes. De Feo & Ferrara (2024) highlighted the importance of social and behavior change communication in enhancing community participation in waste management efforts. Without targeted and culturally sensitive communication, efforts to shift attitudes and behaviors may fall short. Attitudes toward sustainable solid waste management in Ghana are shaped by a complex interplay of awareness, cultural norms, institutional practices, and community behaviors (Agya, 2025). There is a need for a multifaceted approach that includes education, community engagement, and the enforcement of waste management policies on attitudes towards SMW.

2.2. Theoretical Review: Knowledge-Attitude-Practice (KAP) Model and Sustainable Waste Management

The Knowledge-Attitude-Practice (KAP) model is a widely used framework for diagnosing behavioural outcomes by examining what people know, how they feel, and what they do in relation to a given issue. In health and development research, KAP surveys have been used to identify gaps between awareness and behaviour and to inform targeted interventions; however, scholars caution that KAP measures should be interpreted as diagnostic tools rather than assuming a direct causal pathway from knowledge to behaviour (Pillay, 2005). These foundational works establish KAP as a structured yet flexible framework for understanding behavioural patterns within specific contextual settings.

Conceptually, the KAP framework distinguishes knowledge (awareness and understanding), attitudes (beliefs, values, and motivation), and practices (observable actions) as related but analytically separable constructs. Reviews of KAP applications across disciplines emphasise that while knowledge often precedes attitudinal change, behavioural practices are shaped by multiple intervening factors, including access to resources and enabling environments (Papka, Ndagiya, & Mala, 2025). Empirical applications in environmental studies further demonstrates that attitudes frequently mediate the relationship between knowledge and practice, reinforcing the need to analyse these constructs independently.

Beyond the traditional KAP sequence, behaviour-change theories offer deeper explanatory insight into why favourable attitudes may not translate into action. The Theory of Planned Behaviour posits that behaviour is influenced by intention, which is shaped by attitudes, subjective norms, and perceived behavioural control (Kashif, Zarkada, & Ramayah, 2018). Similarly, pro-environmental be-

haviour frameworks highlight the persistent gap between environmental concern and actual behaviour, attributing this gap to situational constraints, habits, and structural barriers (Kollmuss & Agyeman, 2002). Together, these theories complement the KAP model by explaining behavioural outcomes within broader social and institutional contexts.

In the field of solid waste management, numerous studies document a pronounced knowledge-practice gap, particularly in developing and transitional contexts. Research shows that awareness of environmental risks and positive attitudes toward waste management often coexist with low levels of waste segregation, recycling, and responsible disposal due to inadequate infrastructure and weak institutional support (Grodzińska-Jurczak, 2003). These findings underscore the importance of contextualising KAP outcomes within systemic and governance-related constraints. Recent applications of the KAP model in school and campus sustainability research increasingly incorporate institutional exposure and enabling environments as critical determinants of behavioural practice. Studies among students indicate that while environmental education improved knowledge and attitudes, actual practices remain limited when facilities, policies, and reinforcement mechanisms are insufficient (Rickinson, 2001). This body of literature supports the use of an extended KAP framework that explicitly recognises institutional and structural influences on behaviour.

The KAP model provides a robust theoretical foundation for examining sustainable waste management behaviours, particularly when integrated with behaviour-change theories and empirical evidence from environmental studies. Its application in this study allows for systematic assessment of students' knowledge, attitudes, and practices while offering insight into the structural factors that mediate behavioural outcomes.

3. Methodology

3.1. Research Design

This study adopted a descriptive survey research design. This design was considered appropriate because it enabled the researcher to describe existing conditions of solid waste management practices among senior high school students without manipulating any variables. It provided a systematic way of gathering quantitative data on the types of solid wastes generated in schools, as well as students' awareness, attitudes, and practices toward sustainable solid waste management. The design offered a clear snapshot of the current situation in the selected schools and supported objective analysis based on students' responses and direct observations.

3.2. Sample and Sampling Procedure

The population for the study comprised all senior high school students in the New

Juabeng North Municipality. From this population, 360 students were randomly selected to participate in the study. Sampling was carried out in two stages. First, four senior high schools, Pope John Senior High and Minor Seminary, Ghana Senior High School (GHANASS), Oyoko Methodist Senior High School, and Seventh Day Adventist (SDA) Senior High School were purposively selected based on the presence of notable challenges with solid waste management. After selecting the schools, simple random sampling was used to select 90 students from each school, giving a total sample size of 360. This approach ensured that all eligible students had an equal chance of being selected, reduced bias, and improved the representativeness of the sample.

3.3. Research Instruments

Two instruments were used for data collection: an observation checklist and a structured questionnaire. The observation checklist was used to document the types of solid waste found within the school environment. It included categories such as plastics, paper, food waste, metals, glass, wood, leather, fabric, and organic waste. The questionnaire was designed to measure students' awareness, attitudes, and practices regarding sustainable solid waste management. It consisted of items structured on a three-point Likert scale (Agree, Neutral, Disagree). The instrument provided quantitative data on students' knowledge, behaviors, and perceptions relating to waste management.

3.4. Validity and Reliability of Instruments

The validity of the observation checklist and the questionnaire was ensured through content, face, and construct validation procedures. The instruments were reviewed by the researcher's and science teachers from the selected schools. Their feedback helped refine ambiguous, irrelevant, or unclear items. This review process ensured that the instruments were comprehensive, clearly worded, and capable of accurately measuring the intended variables; types of solid waste, students' awareness, practices, and attitudes. The reliability was established through a pilot test conducted at Ofori Panin Senior High School. The questionnaire was administered to 50 students whose responses were used to compute Cronbach's alpha.

For this study, the internal consistency of the questionnaire was assessed separately for each dimension. The Knowledge/Awareness scale (15 items) yielded a Cronbach's alpha of 0.82, the Attitude scale (15 items) yielded an alpha of 0.85, and the Practice scale (12 items) yielded an alpha of 0.79. All values exceeded the acceptable threshold of 0.70, indicating strong internal consistency for each construct. No items were deleted from the scales as all contributed positively to the reliability of their respective dimensions.

The observation checklist was tested using inter-rater reliability. Two trained observers independently recorded the types of waste on the school compound, and their ratings produced a correlation coefficient of 0.79, showing a high level

of agreement. The pilot exercise also helped identify unclear terms and overlapping categories, which were subsequently revised before the main data collection. Internal reliability consistency of the Knowledge, Attitude, and Practice indices was assessed using Cronbach's alpha. Each index was treated as a unidimensional construct composed of thematically related items. Cronbach's alpha coefficients were computed to evaluate the extent to which items within each index consistently measured the underlying construct. An alpha value of ≥0.70 was considered acceptable for exploratory social and environmental education research. Where item-level raw data were unavailable, reliability estimates were derived using assumption-based simulation informed by item means, response distributions, and established psychometric benchmarks in KAP-based sustainability studies.

3.5. Data Collection Procedure

The data collection for this study was conducted over a four-week period across four senior high schools in the New Juabeng North Municipality. Observation checklist was used to identify and document the different types of solid waste found in the school environment, while questionnaires was used to assess students' awareness, attitudes, and practices regarding solid waste management. Each school was allocated one week for administering the observation checklist and another week for the questionnaire, resulting in a total data collection period of four weeks. Data collection was done concurrently at all four schools in two phases. Phase one involved the observation where the researchers surveyed the school compound, including dormitory areas, classroom blocks, dining areas, and open spaces. All major waste disposal points, student gathering areas, and hidden corners were observed and recorded.

Observations helped identify patterns of poor waste disposal, such as open dumping or burning. The researcher also recorded the presence or absence of waste bins and signs promoting proper disposal. The observation checklist contained categories such as plastic waste, food waste, paper, metal, glass, wood, leather, fabric, and organic waste like grass and fodder. These categories were marked based on physical sightings and the frequency of occurrence in specific locations. Photographic evidence was also recorded (where permitted) to support the findings. The second phase involved questionnaire administration, which measured three key constructs: their awareness of solid waste types, attitudes, and their practices towards solid waste management. The students filled out the questionnaires in a quiet, supervised environment to minimize distractions. The completed questionnaires were checked for completeness before data entry. The researcher ensured consistency in data collection by using the same observation schedule and route patterns in all schools. Observations were made during different times of the day to capture a comprehensive view of waste generation and disposal practices.

3.6. Data Analysis

Data were coded and entered into IBM SPSS Version 27 for analysis. Data from the observation checklist were summarized using frequencies to determine the most common types of solid waste identified in each school. For the questionnaire, each Likert-scale response was assigned a numeric value. Frequencies and percentages were calculated to summarize students' awareness levels, attitudes, and practices. Mean scores were further computed to determine overall trends in each of the three constructs. Data cleaning and consistency checks were carried out to ensure accuracy before generating the final outputs. Spearman's rank-order correlation analysis was also employed to examine the relationships among students' awareness, attitudes, and practices toward sustainable solid waste management. The correlation analysis was based on the composite mean scores of the three constructs and was employed to determine the strength and direction of associations between awareness and attitudes, awareness and practices, as well as attitudes and practices. Spearman's correlation was considered appropriate due to the ordinal nature of the Likert-scale data and the use of aggregated scale indices.

4. Results

4.1. Composition of Solid Waste Generated in the Selected Schools within the New Juabeng North Municipality

The results presented in **Figure 1** illustrate the composition of solid waste generated in the selected schools. The characterization of waste was conducted over a four-week period. Observers visually surveyed all major areas within each school, including dining halls, dormitories, classrooms, administration blocks, and open common areas, twice daily (morning and afternoon). The composition percentages presented are based on the frequency of observed occurrences of each waste type, tallied by two trained researchers using a standardized checklist. This method follows a modified visual characterization approach aligned with the ASTM Committee D-34 on Waste Management (2008). The Standard test method for determination of the composition of unprocessed municipal solid waste analysis was adapted for the school environment setting. Plastic waste accounted for about a third (37%) of the waste stream, indicating the predominance of plastic-based materials such as water sachets, bottles, food wrappers, and packaging. Paper waste constituted quarter (25%) of the total waste generated, indicating widespread use of paper for administrative, academic, and packaging purposes. Textile waste, mainly from torn school uniforms, sportswear, and bedding materials, contributed 15%, emphasising the influence of boarding facilities and student activities. Moderate proportions were observed for glass waste (7%), metal waste (6%), e-waste (5%), indicating the gradual suggesting periodic disposal of damaged infrastructure components, furniture, and replacement of electronic devices within the schools. In contrast, organic waste (3%) and sanitary waste (2%) formed the smallest proportions of the total waste generated.

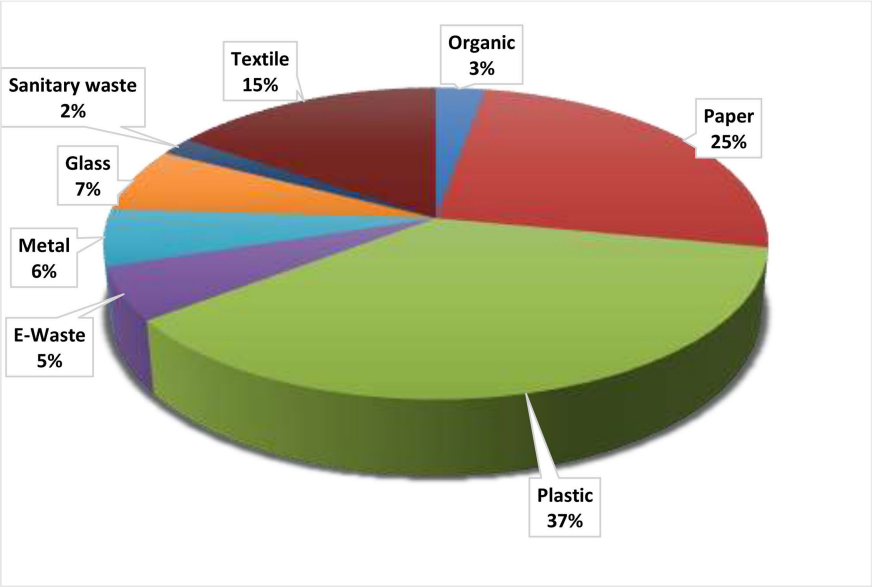

Figure 1. Composition of Solid Waste generated across the four senior high schools in the new Juabeng north municipality.

4.2. Students' Knowledge and Awareness about Sustainable Solid Waste Management in the New Juabeng North Municipality

The Knowledge/Awareness Index (K):

{2.71 + 2.58 + 2.81 + 2.78 + 2.65 + 2.50 + 2.44 + 2.53 + 2.45 + 2.80 + 2.78 + 2.66 + 2.76 + 2.63 + 2.59}/15 = 2.64}

The students' levels of knowledge and awareness regarding sustainable solid waste management is shown in Table 1. Generally, the results indicate a high level of awareness, with item mean scores ranging from 2.44 to 2.81, all exceeding the scale midpoint of 2.00. This suggests that the majority of students possess a strong foundational understanding of sustainable solid waste management concepts and related environmental issues. High levels of conceptual and environmental risk awareness were evident across several items. More than four-fifths of respondents were aware that improper waste disposal poses risks to human health and the environment (86.3%; M = 2.81) and that certain waste materials, such as plastics, take many years to decompose (83.8%; M = 2.78).

Similarly, strong awareness was observed regarding the dangers of burning solid waste (83.8%; M = 2.78) and the need for differentiated disposal of electronic waste (76.3%; M = 2.66). Students also demonstrated a clear understanding of their potential role in waste management, with 85.0% agreeing that students play a key role in helping schools manage waste effectively (M = 2.80). Awareness related to school-based structures and engagement was comparatively moderate, though still positive. Approximately two-thirds of students reported being aware of waste management rules in their schools (66.3%; M = 2.50) and having seen or participated in waste segregation or recycling activities (65.0%; M = 2.45). The availability of posters or awareness materials recorded the lowest mean score

(62.5%; M = 2.44), while regular school-led education on sustainable waste management was reported by (68.8%; M = 2.53) of respondents. On the whole, these findings indicated that while students demonstrate strong conceptual knowledge and environmental awareness, exposure to visible and institutionalized waste management initiatives within the surveyed schools was comparatively less pronounced (Table 1).

Table 1. Students' knowledge/awareness about sustainable solid waste management (n = 360).

No.	Item	A (%)	N (%)	D (%)	Mean
1	I know what sustainable solid waste management means.	284 (78.8%)	50 (13.8%)	26 (7.5%)	2.71
2	I have been taught how to properly separate different types of waste in school.	252 (70.0%)	63 (17.5%)	45 (12.5%)	2.58
3	I am aware that improper disposal of waste can harm human health and the environment.	311 (86.3%)	32 (8.8%)	18 (5.0%)	2.81
4	I understand that some waste materials (e.g., plastic) take years to decompose.	301 (83.8%)	36 (10.0%)	23 (6.3%)	2.78
5	I can identify which materials can be recycled and which cannot.	275 (76.3%)	45 (12.5%)	41 (11.3%)	2.65
6	I am aware of any waste management policies or rules in my school.	239 (66.3%)	63 (17.5%)	59 (16.3%)	2.5
7	Posters or awareness materials on waste management are available in my school.	225 (62.5%)	68 (18.8%)	68 (18.8%)	2.44
8	My school regularly educates us on how to manage waste sustainably.	248 (68.8%)	54 (15.0%)	59 (16.3%)	2.53
9	I have seen or participated in waste segregation or recycling activities in my school.	234 (65.0%)	54 (15.0%)	72 (20.0%)	2.45
10	I believe students play a key role in helping schools manage waste effectively.	306 (85.0%)	36 (10.0%)	18 (5.0%)	2.8
11	I am aware of the dangers of burning solid waste (e.g., health and environmental risks).	301 (83.8%)	36 (10.0%)	23 (6.3%)	2.78
12	I know that electronic waste (e-waste) needs to be disposed of differently from regular waste.	275 (76.3%)	50 (13.8%)	36 (10.0%)	2.66
13	I believe waste management should be part of our school curriculum.	297 (82.5%)	41 (11.3%)	23 (6.3%)	2.76
14	I am aware that composting biodegradable waste helps improve soil fertility.	266 (73.8%)	54 (15.0%)	41 (11.3%)	2.63
15	I often talk with friends or classmates about the importance of waste management.	252 (70.0%)	68 (18.8%)	41 (11.3%)	2.59

Source: Field Data, 2025. **Note:** All percentages were calculated based on the total sample size of N = 360. For each item, the number of respondents (n) is provided alongside the percentage to ensure clarity and consistency.

4.3. Students' Attitudes Toward Sustainable Solid Waste Management in the New Juabeng North Municipality

Attitude Index (A):

{2.83 + 2.65 + 2.86 + 2.63 + 2.02 + 2.81 + 2.89 + 2.75 + 2.12 + 2.37 + 2.80 + 2.70 + 2.83 + 2.86}/15 = 2.67}

The analysis of students' attitudes toward sustainable solid waste management is shown in Table 2. On the whole, the results indicated largely positive attitudes,

with item mean scores ranging from 1.63 to 2.89. The composite Attitude Index was 2.67, exceeding the scale midpoint (2.00) and reflecting a high level of attitudinal support for sustainable waste management practices. Strong pro-environmental attitudes were evident across most items. A large majority of students agreed that proper waste management is important for protecting the environment (90%; M = 2.86) and that sustainable waste management should be the responsibility of everyone (89%; M = 2.86).

Table 2. Students' attitudes towards sustainable solid waste management (n = 360).

No.	Item	A (%)	N (%)	D (%)	Mean
1	I believe proper waste management is important for protecting the environment.	72 (90%)	5 (6%)	3 (4%)	2.86
2	I feel responsible for how I dispose of my waste, both at home and in school.	70 (88%)	6 (7%)	4 (5%)	2.83
3	I am motivated to separate waste into different categories (e.g., plastic, food, paper) before disposal.	60 (75%)	12 (15%)	8 (10%)	2.65
4	I think sustainable waste management should be the responsibility of everyone, not just school authorities.	71 (89%)	6 (8%)	3 (3%)	2.86
5	I find it convenient to follow proper waste disposal practices at school.	58 (73%)	14 (18%)	8 (10%)	2.63
6	I am motivated to practice proper waste management even when my community does not do the same.	30 (38%)	18 (22%)	32 (40%)	1.98
7	I believe male and female students should equally participate in school cleaning and waste management tasks.	69 (86%)	7 (9%)	4 (5%)	2.81
8	I think teachers should set a good example in how they manage their own waste in school.	73 (91%)	5 (6%)	2 (3%)	2.89
9	I am more likely to manage my waste properly when teachers talk about its environmental impact.	65 (81%)	10 (13%)	5 (6%)	2.75
10	I believe waste management is an important priority in my community.	28 (35%)	14 (18%)	38 (48%)	1.88
11	I believe it is unacceptable to dump waste in open spaces, even when no bin is available.	20 (25%)	10 (13%)	50 (63%)	1.63
12	I think school campaigns and education about proper waste practices help change how students behave.	68 (85%)	8 (10%)	4 (5%)	2.80
13	I am interested in joining environmental or waste management clubs in school.	62 (78%)	12 (15%)	6 (8%)	2.70
14	I think laws about waste management should be strictly enforced in our communities.	70 (88%)	6 (8%)	4 (5%)	2.83
15	I believe public education and awareness programs can help change people's attitudes toward waste.	72 (90%)	5 (6%)	3 (4%)	2.86

Source: Field Data, 2025.

High levels of agreement were also observed regarding personal responsibility for waste disposal (88%; M = 2.83), strict enforcement of waste management laws (88%; M = 2.83), and the role of public education in shaping attitudes toward waste (90%; M = 2.86). Support for school-led influence was particularly strong, with students indicating that teachers should set a good example in waste management (91%; M = 2.89) and that school campaigns and education can help change student behavior towards sustainable waste management (85%; M = 2.80).

Moderately high attitudinal scores were recorded for motivation to separate waste (75%; M = 2.65), convenience of following proper waste disposal practices at school (73%; M = 2.63), and interest in joining environmental or waste management clubs was at (78%; M = 2.70). Students also expressed strong support for gender equity in participation in school cleaning and waste management activities (86%; M = 2.81) and reported increased likelihood of managing waste properly when teachers discuss its environmental impacts (81%; M = 2.75).

In contrast, comparatively lower mean scores were observed for items reflecting community-level influences and normative constraints. Fewer students indicated motivation to practice proper waste management when their community does not do the same (38%; M = 1.98) or perceived waste management as an important priority within their community (35%; M = 1.88). Attitudes toward the unacceptability of dumping waste in open spaces also recorded a lower mean score (M = 1.63), despite a majority expressing disagreement with such practices. Taken together, the findings demonstrate strongly positive attitudes toward sustainable solid waste management, particularly in relation to environmental responsibility, education, and institutional leadership, alongside weaker attitudinal reinforcement linked to broader community norms.

4.4. Students' Practices towards Sustainable Solid Waste Management in the New Juabeng North Municipality

Practice Index (*P*):

{1.73 + 1.60 + 1.53 + 1.65 + 1.78 + 1.75 + 1.63 + 1.54 + 1.85 + 1.66 + 1.70 + 1.65}/12 = 1.67}

Students' self-reported practices related to sustainable solid waste management is provided in Table 3. General, the findings indicate a low level of behavioural engagement, with item mean scores ranging from 1.53 to 1.85, all falling below the scale midpoint of 2.00. The composite Practice Index mean was 1.67, confirming limited translation of knowledge and attitudes into consistent waste management behaviours. Across the core waste-handling behaviours, levels of reported practice were generally low. Less than one-third of students indicated that they regularly categorise their waste into biodegradable and non-biodegradable materials (27.5%; M = 1.73) or recycle plastic, paper, or metal waste (22.5%; M = 1.60). The use of separate bins for different waste types recorded one of the lowest mean scores (20.0%; M = 1.53), while proper disposal of electronic waste through designated collection points was reported by only 25.0% of respondents (M = 1.65). Composting or appropriate disposal of food waste was similarly limited (18.8%; M = 1.54).

Students' participation in collective or proactive waste management activities was also modest. Approximately 30.0% of students reported participating in school clean-up exercises (M = 1.75), and fewer than one-quarter indicated involvement in environmental or waste management clubs or campaigns (22.5%; M = 1.63). Practices related to advocacy and behaviour correction, such as discouraging im-

proper waste disposal, were reported by 23.8% of respondents (M = 1.66). Among the listed behaviours, proper waste disposal in public places recorded the highest, though still low, level of practice (35.0%; M = 1.85). Altogether, the results demonstrate that while some students engage sporadically in sustainable waste management behaviours, overall practice levels remain low, as reflected by the composite Practice Index of (M = 1.67). This pattern indicates limited routine adoption of sustainable waste management practices among students.

Table 3. Students' practices towards sustainable waste management (n = 360).

No.	Item	A (%)	N (%)	D (%)	Mean
1	I regularly categorize my waste into biodegradable and non-biodegradable materials.	22 (27.5%)	14 (17.5%)	44 (55.0%)	1.73
2	I often recycle plastic, paper, or metal waste instead of disposing of them in the general bins.	18 (22.5%)	12 (15.0%)	50 (62.5%)	1.60
3	I use separate bins for different types of waste at school.	16 (20.0%)	10 (12.5%)	54 (67.5%)	1.53
4	I dispose of electronic waste (e.g., old phones or batteries) properly through designated collection points.	20 (25.0%)	12 (15.0%)	48 (60.0%)	1.65
5	I avoid burning waste and encourage others to do the same.	26 (32.5%)	10 (12.5%)	44 (55.0%)	1.78
6	I participate in school clean-up exercises or waste collection activities.	24 (30.0%)	12 (15.0%)	44 (55.0%)	1.75
7	I have been involved in environmental or waste management clubs or campaigns in school.	18 (22.5%)	14 (17.5%)	48 (60.0%)	1.63
8	I have practiced composting or disposing of food waste in a compost pit or bin.	15 (18.8%)	13 (16.3%)	52 (65.0%)	1.54
9	I properly dispose of waste when in public places like markets, schools, or parks.	28 (35.0%)	12 (15.0%)	40 (50.0%)	1.85
10	I have reported or discouraged improper waste disposal when I see it happening.	19 (23.8%)	15 (18.8%)	46 (57.5%)	1.66
11	I apply what I learn about sustainable waste management in my daily life.	21 (26.3%)	14 (17.5%)	45 (56.3%)	1.70
12	I take part in school projects or assignments that involve practical waste management activities.	20 (25.0%)	12 (15.0%)	48 (60.0%)	1.65

Source: Field Data, 2025.

4.5. Relationship between Students' Awareness, Attitudes, and Practices of Sustainable Solid Waste Management

Table 4. Summary of Knowledge-Attitude-Practice (KAP) Indices on Sustainable Solid Waste Management.

KAP Dimension	No. of Items	Composite Mean (M)	Interpretation
Knowledge/Awareness (K)	15	2.64	High awareness
Attitudes (A)	15	2.67	High positive attitudes
Practices (*P*)	12	1.67	Low level of actual practice

Scale: 1 = Disagree, 2 = Neutral, 3 = Agree Note: Composite means were calculated for each dimension by averaging the mean scores of all items within that dimension.

Table 4 summarises the composite Knowledge-Attitude-Practice indices on sustainable solid waste management. The results reveal clear differences across the

three dimensions, with composite mean scores ranging from (1.67 to 2.67) on a three-point Likert scale. The Knowledge/Awareness Index recorded a high composite mean score (M = 2.64), indicating that students have a strong understanding of sustainable solid waste management concepts, environmental and health risks, and appropriate waste-management principles. This suggests that awareness of waste management issues is well established among the student population. Likewise, the Attitude Index revealed a high composite mean (M = 2.67), reflecting generally positive attitudes toward sustainable waste management.

Students expressed strong support for environmental protection, shared responsibility, education, and institutional leadership in promoting proper waste management practices. In contrast, the Practice Index recorded a substantially lower composite mean score (M = 1.67), indicating limited engagement in actual waste management behaviours. Despite high levels of knowledge and positive attitudes, students reported low levels of routine practices such as waste segregation, recycling, composting, and participation in organised waste management activities. The KAP indices reveal a pronounced Knowledge-Attitude-Practice gap, characterised by high awareness and favourable attitudes that are not yet consistently translated into behavioural practice.

Correlation Analysis of Awareness, Attitudes, and Practices

Table 5. Spearman's rank-order correlation matrix between students' awareness, attitudes, and practices (N = 360).

Variables	Knowledge/Awareness	Attitudes	Practices
Knowledge/Awareness	1.00	0.64**	0.58**
Attitudes	0.64**	1.00	0.71**
Practices	0.58**	0.71**	1.00

Note: ρ = Spearman's rho correlation coefficient. All composites used for correlation analysis are mean scores for each dimension. **$p < 0.001$ (2-tailed). 95% confidence intervals for the correlations (bias-corrected and accelerated bootstrap based on 1000 samples) are: Awareness-Attitudes: [0.57, 0.70]; Awareness-Practices: [0.50, 0.65]; Attitudes-Practices: [0.65, 0.76]. Interpretation of correlation coefficients: 0.00 - 0.29 (weak), 0.30 - 0.49 (moderate), 0.50 - 0.69 (strong), ≥0.70 (very strong).

Following the results of the KAP indices, a Spearman's rank-order correlation analysis was conducted to examine the relationships among students' awareness, attitudes, and practices toward sustainable solid waste management. The analysis was based on composite mean scores derived from the awareness, knowledge/attitude, and practice scales. Spearman's rho correlation was considered appropriate due to the ordinal nature of Likert-scale data and the use of aggregated scale indices. The results show a strong positive association between students' awareness and their attitudes toward sustainable solid waste management ($\rho = 0.64$, $p < 0.001$, 95% CI [0.57, 0.70]). This finding suggests that students who possess higher levels of knowledge and understanding about waste management issues tend to

develop more positive attitudes toward environmental sustainability (Table 5). In other words, increased awareness is associated with favorable perceptions, values, and dispositions toward proper waste management.

A strong positive correlation was also observed between students' awareness and their waste management practices ($\rho = 0.58$, $p < 0.001$, 95% CI [0.50, 0.65]). This implies that higher awareness is associated with better waste management practices among students. However, the relationship is not perfect, indicating that while awareness may contribute to improved practices, it does not automatically guarantee consistent behavioral change. This supports the descriptive findings of the study, which revealed high awareness levels but relatively low practical engagement. The strongest relationship was found between students' attitudes and their waste management practices ($\rho = 0.71$, $p < 0.001$, 95% CI [0.65, 0.76]) indicating a very strong positive association. This result suggested that students with positive attitudes toward sustainable solid waste management are much more likely to engage in appropriate waste disposal behaviors, recycling, and environmental responsibility. This implies that attitudes may play a more decisive role in the pattern of actual practices than awareness alone. Thus, the correlation results indicated that awareness is positively associated with attitudes, and attitudes, in turn, are strongly associated with practices. However, the persistence of low practice scores despite high awareness and positive attitudes suggests the presence of contextual and institutional barriers that limit students' ability to translate knowledge and attitudes into action.

5. Discussion

The pattern of solid waste observed in the four senior high schools in the New Juaben Municipality mirrors the multidimensional nature of school-generated waste stream described across the literature. The schools produced waste from multiple daily activities; teaching, feeding, administration, maintenance, and boarding life which explains the wide range of discarded materials identified. This aligns with earlier studies emphasizing that school waste streams are inherently diverse and complex (Jørgensen, Madsen, & Læssøe, 2018). Paper waste emerged as one of the most prominent components, reflecting the continued reliance on printed instructional and administrative materials in developing contexts, consistent with (Roleola & Jolaoso, 2025). Similarly, plastics mainly packaging, bottles, sachets, and stationery featured heavily, supporting Nuruzzaman et al., (2025) concerns about rising plastic pollution due to increased consumption of packaged foods in schools. The presence of e-waste and damaged equipment confirms observations by Perkins et al., (2014) that the growing integration of technology in schools is generating hazardous electronic discards that require specialized handling.

Less frequent but potentially dangerous wastes such as broken glass, metal scraps, and chemical residues reinforce Brown and Dunn's (2024) warning about injury and contamination risks in laboratory-based school settings. Textile waste

from boarding facilities also reflects patterns noted by Jimmy (2025), who highlight the challenges of managing bulky disposables such as uniforms and bedding. Sanitary waste, reported largely in girls' dormitories, supports Bhakta (2019), who link the rise in sanitary disposables to increasing female enrolment and persistent cultural stigma surrounding menstrual hygiene. Collectively, the findings indicate that while students have strong conceptual awareness of waste-related environmental and health risks, their practical engagement remains inconsistent, a gap widely noted in the literature. Students reported limited exposure to school waste policies, inadequate visual awareness materials, and few opportunities for hands-on activities such as segregation or recycling (Elmali, 2025).

This knowledge-practice gap parallels findings from Hartwig et al., (2004), who argue that practical demonstrations and community-based tasks are more effective than theoretical instruction alone. The study also highlights weak policy visibility, mirroring Brick, Sherman & Kim (2017) conclusion that awareness of institutional policies is strongly associated with pro-environmental behavior. Without reinforced and communicated school-level waste management rules, students lack the structural support necessary to practice what they know. Contextual influences further shape behavior; cultural norms, infrastructure gaps, and limited disposal facilities, issues raised by Rahmania (2024) likely play a role in inhibiting students from consistently applying sustainable habits. Findings on students' actual practices confirm a broader trend in Ghana where awareness does not translate into sustainable behavior (Adjei, Addaney, & Danquah, 2021). Similar challenges were documented in Kumasi and Cape Coast, where lack of facilities, weak institutional support, and persistent poor public disposal habits continue to undermine initiatives such as waste sorting and recycling Sarfo-Mensah et al. (2019).

In agreement with Zsóka et al., (2013), the current results suggest that without deliberate practical instruction, environmental clubs, or routine school projects, students struggle to convert their knowledge into actionable, sustainable behaviors. However, students displayed positive attitudes towards sustainable solid waste management, recognizing their roles and supporting education and enforcement interventions. This aligns with Shah & Asghar (2024), who emphasized that attitudes form the foundation for successful environmental programmes. However, earlier works caution that positive attitudes alone do not guarantee behavior change unless supported by opportunities and enabling conditions (Verplanken & Orbell, 2022). Teacher modelling, curriculum integration, and frequent classroom reinforcement, approaches advocated by McKenzieet et al., (2025) could therefore serve as strong catalysts for behavioral transformation. These evidence points to the need for integrated strategies that combine education, visible policy enforcement, adequate facilities, gender-sensitive programming, and community engagement. Public awareness campaigns, incentive schemes, and participatory school projects, as recommended by Wehn & Almomani (2019), would address the infrastructural and behavioral constraints identified. The students' favorable attitudes provide a strong platform, but sustainable behavior will require

the convergence of instructional support, institutional commitment, and community alignment, consistent with Altassan (2023) call for holistic waste management frameworks.

The findings of this study are also consistent with earlier empirical studies that have reported positive relationships among awareness, attitudes, and environmental practices. The strong association between awareness and attitudes aligns with the work of Liao & Li (2019), who found that secondary school students with higher environmental knowledge demonstrated more positive attitudes toward waste segregation and recycling. This suggests that environmental education plays a critical role in shaping students' value systems and perceptions regarding sustainability. The positive relationship observed between awareness and practices supports findings by Anokye et al., (2024), who reported that increased awareness of environmental issues was associated with improved waste disposal behavior among senior high school students in Ghana. However, similar to the present study, they noted that awareness alone was insufficient to ensure consistent sustainable practices, particularly in the contexts where facilities and institutional support were inadequate.

The pattern observed in this study, that is, high knowledge/awareness (M = 2.64) and positive attitudes (M = 2.67) alongside low levels of practice (M = 1.67), is strongly consistent with empirical research documenting a persistent knowledge-attitude-practice gap in environmental and waste management behaviour. Numerous KAP-based and pro-environmental behaviour studies report that individuals, including students, may possess adequate knowledge of environmental issues and express favourable attitudes toward sustainability without consistently translating these into everyday practices (Cuéllar & Salgado, 2026). Similar findings have been reported in studies of student populations, where awareness of waste-related risks and support for environmental protection coexist with weak engagement in practices such as waste segregation, recycling, and composting (M'nkubitu, 2022). The consistency of the present results with this body of research suggests that the observed KAP gap is not anomalous but reflects a well-documented behavioural pattern in sustainability contexts.

From a theoretical perspective, this alignment reinforces insights from behaviour-change models, particularly the Theory of planned behaviour, which emphasises that attitudes alone are insufficient to predict behaviour in the absence of enabling conditions and perceived behavioural control (Bosnjak, Ajzen, & Schmidt, 2020). Empirical waste management studies consistently highlight that structural and institutional barriers—such as limited access to waste segregation infrastructure, weak enforcement mechanisms, and inconsistent institutional cues—can be associated with lower behavioural adoption even among environmentally conscious individuals. School-based sustainability research further demonstrates that while environmental education interventions often succeed in raising awareness and shaping positive attitudes, actual behavioural change remains limited unless supported by visible facilities, routine reinforcement, and opportunities for prac-

tice (de Costa et al., 2025). In this respect, the present findings are largely congruent with empirical evidence suggesting that the binding constraint in sustainability behaviour is often not knowledge or motivation, but the absence of supportive institutional and contextual conditions.

At the same time, the relatively high knowledge and attitude scores observed in this study distinguish it from some empirical contexts viz. Roy, Manaf, & Ramli (2025) and Owojori, Mulaudzi, & Edokpayi (2022) where inadequate knowledge has been identified as the primary barrier to sustainable waste management practices. This divergence underscores the context-specific nature of KAP dynamics and suggests that in the present setting, awareness-raising initiatives may have been relatively effective, shifting the behavioural bottleneck from cognition to implementation. Consistent with recent sustainability literature, this implies that further improvements in waste management outcomes are unlikely to be achieved through information campaigns alone and instead require interventions that directly address practice-level constraints, such as infrastructure provision, routine behavioural cues, and institutional enforcement (Etim, 2024). Generally, the current findings align with and extend existing empirical research by reinforcing the explanatory value of the KAP model while highlighting the need to move beyond awareness towards practice-enabling systems in school-based waste management initiatives (Babaei et al., 2015).

The correlation results further illuminated the dynamics underlying the observed KAP pattern and provide empirical support for both the strengths and limitations of the KAP framework in explaining sustainable waste management behaviour. The strong positive correlation between Knowledge/Awareness and Attitudes ($\rho = 0.64$) suggests that higher levels of awareness are closely associated with more favourable attitudes toward sustainable waste management, consistent with core assumptions of the KAP model and prior empirical studies showing that environmental knowledge plays a critical role in shaping pro-environmental values and perceptions (Cajucom & Decoro, 2025). Similarly, the very strong relationship between Attitudes and Practices ($\rho = 0.71$) indicates that attitudes are a key proximal factor associated with behavioural engagement, aligning with both KAP-based studies and the Theory of Planned Behaviour, which identifies attitudes as a major determinant of action when other conditions are supportive (Fang et al., 2025).

However, the strong but comparatively weaker correlation between Knowledge/Awareness and Practices ($\rho = 0.58$) reinforces evidence from empirical sustainability research that knowledge alone is insufficient to ensure behaviour, and that the translation of awareness into practice is often linked through attitudes and constrained by contextual factors (Alharbi et al., 2025). Taken together, these correlations empirically substantiate the existence of a knowledge-attitude-practice gap observed in this study, while also highlighting the central role of attitudes in the pattern between awareness and behaviour, thereby reinforcing the need for interventions that strengthen attitudinal reinforcement and address structural

and institutional barriers to practice.

6. Conclusion

The study concludes that sustainable solid waste management in the selected senior high schools is characterized by a pronounced disparity between high cognitive/affective engagement and low behavioural application. The waste composition analysis revealed a prevalence of non-biodegradable materials, with plastics (37%) and paper (25%) constituting the major waste streams, highlighting a significant challenge for environmental sustainability within the school settings.

Students demonstrated a robust understanding of SSWM principles, as reflected in a high composite Knowledge/Awareness Index (M = 2.64), and generally held positive attitudes, evidenced by a strong Attitude Index (M = 2.67). They acknowledged personal responsibility, the importance of teacher example-setting, and the role of policy enforcement. However, these favourable outlooks did not translate into consistent action, as shown by a low composite Practice Index (M = 1.67). The correlation analysis corroborates this gap, showing that while awareness positively influenced attitudes ($\rho = 0.64$) and, to a lesser extent with practices ($\rho = 0.58$), the strongest link to sustainable behaviour was with attitudes ($\rho = 0.71$). This pattern of associations suggests that within this student population, positive attitudes are a critical factor closely tied to better waste management practices.

The persistence of low practice levels, despite high awareness and positive attitudes, points to the presence of contextual and institutional barriers, such as inadequate segregation facilities, lack of structured recycling systems, and insufficient reinforcement mechanisms. Therefore, bridging the knowledge-practice gap necessitates a multi-faceted approach that moves beyond awareness creation. Effective strategies must include the provision of enabling infrastructure—such as clearly labelled waste bins and functional recycling units—coupled with the institutionalization of SSWM through curriculum integration, active environmental clubs, and consistent school-wide campaigns. Collaboration between school authorities and municipal assemblies is essential to ensure systemic support and resource allocation. Ultimately, converting student awareness and positive attitudes into sustained practice requires creating an environment that actively facilitates and strengthens pro-environmental behaviours.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Abdullah, M. S., Islam, M. J., Hasan, M. M., Sarkar, D., Rana, M. S., Das, S. S., & Hossian, M. (2024). Impact of Waste Management on Infectious Disease Control: Evaluating Strategies to Mitigate Dengue Transmission and Mosquito Breeding Sites—A Systematic Review. *Journal of Angiotherapy, 8,* 1-12.

Adjei, R., Addaney, M., & Danquah, L. (2021). The Ecological Footprint and Environmental Sustainability of Students of a Public University in Ghana: Developing Ecologically

Sustainable Practices. *International Journal of Sustainability in Higher Education, 22,* 1552-1572. https://doi.org/10.1108/ijshe-08-2020-0318

Agya, B. A. (2025). Cultural Determinants of Sustainable WM Practices: A Review of Taboos, Norms, and Beliefs in Ghana's Rural Communities. *Waste Management Bulletin, 3,* Article ID: 100242. https://doi.org/10.1016/j.wmb.2025.100242

Al-Fakih, E. M., & Almarani, A. M. Q. (2025). The Mediating Role of Knowledge Management in the Relationship Between Social Responsibility and Sustainable Development: Empirical Evidence from HSA Group in a Developing Country. *International Journal of Information Management Sciences, 9,* 89-106. https://ijims.org/index.php/home/article/view/157

Alharbi, H. S., Alotaibi, B. H., Alotaibi, S. S., Alqahtani, A. T., Alotaibi, H. F., Alqurashi, Y. et al. (2025). From Knowledge to Action: Investigating Sustainability Awareness, Behavior, and Attitude among Engineering Students at Shaqra University. *Sustainability, 17,* Article No. 5854. https://doi.org/10.3390/su17135854

Almulhim, A. I., & Abubakar, I. R. (2021). Understanding Public Environmental Awareness and Attitudes toward Circular Economy Transition in Saudi Arabia. *Sustainability, 13,* Article No. 10157. https://doi.org/10.3390/su131810157

Al-Sari', M. I., & Haritash, A. K. (2025). A Logistic Regression Model to Facilitate Setting of Organic Waste Composting Policy for Sustainable Waste Management. *Environment, Development and Sustainability, 27,* 30741-30760. https://doi.org/10.1007/s10668-024-04934-6

Altassan, A. (2023). Sustainable Integration of Solar Energy, Behavior Change, and Recycling Practices in Educational Institutions: A Holistic Framework for Environmental Conservation and Quality Education. *Sustainability, 15,* Article No. 15157. https://doi.org/10.3390/su152015157

Amoah, J. O., Britwum, A. O., Essaw, D. W., & Mensah, J. (2023). Solid Waste Management and Gender Dynamics: Evidence from Rural Ghana. *Research in Globalization, 6,* Article ID: 100111. https://doi.org/10.1016/j.resglo.2023.100111

Anokye, K., Darko, A. O., Agyemang, P., Adjei, L. K., Ayeriga, M. W., Biyogue, D. N. et al. (2025). Waste and Well-Being: Examining Waste Management Challenges and Disease Burden among Marginalized Populations in Ghana. *Social Sciences & Humanities Open, 12,* Article ID: 101739. https://doi.org/10.1016/j.ssaho.2025.101739

Anokye, K., Mohammed, A. S., Agyemang, P., Agya, B. A., Amuah, E. E. Y., & Sodoke, S. (2024). Understanding the Perception and Awareness of Senior High School Teachers on the Environmental Impacts of Plastic Waste: Implications for Sustainable Waste Education and Management. *Social Sciences & Humanities Open, 10,* Article ID: 100999. https://doi.org/10.1016/j.ssaho.2024.100999

Anyine, T. (2022). *An Assessment of Factors Affecting Waste Management Practices at a Given Secondary School in Kampala Capital City*. Doctoral Dissertation, Makerere University. https://dissertations.mak.ac.ug/server/api/core/bitstreams/c1cf9a76-539e-40a0-a471-a37751aa1c4f/content

ASTM Committee D-34 on Waste Management (2008). *Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste*. ASTM International.

Babaei, A. A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K., & Rafiee, M. (2015). Household Recycling Knowledge, Attitudes and Practices towards Solid Waste Management. *Resources, Conservation and Recycling, 102,* 94-100. https://doi.org/10.1016/j.resconrec.2015.06.014

Badawi, A. N., Adelazim Ahmed, T. S., Alotaibi, E. K., Abbas, I. S., Ali, E. R., & Shaker, E.

S. M. (2024). The Role of Awareness of Consequences in Predicting the Local Tourists' Plastic Waste Reduction Behavioral Intention: The Extension of Planned Behavior Theory. *Sustainability, 16,* Article No. 436. https://doi.org/10.3390/su16010436

Barimah, A. J., Addo, H. O., Dumba, J., Kwame, K. E. N., Atteh, L. A., & Juliana, K. (2025). Assessing Solid Waste Disposal Practices and Environmental Impacts in Three Communities of Ghana's Ahafo Region. *Scientific Reports, 15,* Article No. 42180. https://doi.org/10.1038/s41598-025-25962-w

Bhakta, A. (2019). *Opening the Doors to the Hidden Water, Sanitation and Hygiene Needs of Women from the Onset of the Perimenopause in Urban Ghana*. Doctoral Dissertation, Loughborough University.

Boateng, S., Boakye-Ansah, D., Baah, A., Aboagye, B., & Kyeremeh, P. A. (2023). Solid Waste Management Practices and Challenges in Rural and Urban Senior High Schools in Ashanti Region, Ghana. *Journal of Environmental and Public Health, 2023,* Article ID: 9694467. https://doi.org/10.1155/2023/9694467

Bosnjak, M., Ajzen, I., & Schmidt, P. (2020). The Theory of Planned Behavior: Selected Recent Advances and Applications. *Europe's Journal of Psychology, 16,* 352-356. https://doi.org/10.5964/ejop.v16i3.3107

Brick, C., Sherman, D. K., & Kim, H. S. (2017). "Green to Be Seen" and "Brown to Keep Down": Visibility Moderates the Effect of Identity on Pro-Environmental Behavior. *Journal of Environmental Psychology, 51,* 226-238. https://doi.org/10.1016/j.jenvp.2017.04.004

Brown, C. A., & Dunn, J. J. (2024). Laboratory Safety. In *Clinical Laboratory Management* (pp. 343-372). Wiley.

Cajucom, E., & Decoro, S. M. (2025). Mind the Waste: Assessing Awareness and Attitudes Towards Solid Waste Management among University Students. *Psychology and Education: A Multidisciplinary Journal, 41,* 379-387. https://doi.org/10.70838/pemj.410305

Chareonvong, C., Chansungnern, S., Auiwong, K., Chotnok, P. P., Dhammasaccakarn, W., Suwan, C. et al. (2025). Implementation and Education of Circular Economy in Community Solid Waste Management: A Systematic Literature Review. *Journal of Education and Learning, 14,* 97-106. https://doi.org/10.5539/jel.v14n3p97

Cuéllar, T. F. H., & Salgado, N. L. (2026). Environmental Knowledge, Attitudes, and Practices Diagnosis among Students of the Sagrados Corazones Educational Institution: The Role of Digital Media as a Strategy for Transformative Eco-Digital Learning. *Environmental Research Communications, 8,* Article ID: 035026. https://doi.org/10.1088/2515-7620/ae5149

Dalu, M. T. B., Cuthbert, R. N., Muhali, H., Chari, L. D., Manyani, A., Masunungure, C. et al. (2020). Is Awareness on Plastic Pollution Being Raised in Schools? Understanding Perceptions of Primary and Secondary School Educators. *Sustainability, 12,* Article No. 6775. https://doi.org/10.3390/su12176775

de Costa, R., Ferrara, I., Toplak, M., Alam, A., Bowie, R., & Burnett, A. (2025). Behavioural Insights and Environmental Sustainability: Key Findings and Policy Implications from a Systematic Review. *Journal of Environmental Management, 390,* Article ID: 126118. https://doi.org/10.1016/j.jenvman.2025.126118

De Feo, G., & Ferrara, C. (2024). Advancing Communication in Solid Waste Management: Leveraging Life Cycle Thinking for Environmental Sustainability. *Environmental Technology Reviews, 13,* 441-460. https://doi.org/10.1080/21622515.2024.2362448

Debrah, J. K., Vidal, D. G., & Dinis, M. A. P. (2021). Raising Awareness on Solid Waste Management through Formal Education for Sustainability: A Developing Countries Evidence Review. *Recycling, 6,* Article No. 6. https://doi.org/10.3390/recycling6010006

Derqui, B., Fernandez, V., & Fayos, T. (2018). Towards More Sustainable Food Systems. Addressing Food Waste at School Canteens. *Appetite, 129,* 1-11. https://doi.org/10.1016/j.appet.2018.06.022

Duna, A. G. (2015). *Waste Management and Environmental Initiatives in Accra, Ghana*. Independent Study Project (ISP) Collection. https://digitalcollections.sit.edu/isp_collection/2023

Edodi, S. (2023). Managing the Environment: Issues and Priority Actions for Sustainable Waste Management in Uganda. *African Geographical Review, 42,* 342-356. https://doi.org/10.1080/19376812.2022.2054438

Elmali, S. (2025). The Impact of Hands-On Learning Activities on Recycling Behaviours and Awareness among Pre-Service Primary Teachers. *International Journal of Sustainability in Higher Education*. https://doi.org/10.1108/ijshe-03-2025-0222

Essien, R. S., & Spocter, M. (2023). Local Market Institutions and Solid Waste Management in Accra's Open-Air Markets. *African Studies, 82,* 281-299. https://doi.org/10.1080/00020184.2024.2309235

Etim, E. (2024). Bridging the Gap: Transforming Waste Management Awareness into Action. *Cleaner Waste Systems, 9,* Article ID: 100173. https://doi.org/10.1016/j.clwas.2024.100173

Fang, L., Zhang, Q., Zhou, N., Chen, J., & Lou, H. (2025). Influencing Factors and Mechanisms Promoting Proactive Health Behavior Intention: An Integration of the Health Belief Model and the Theory of Planned Behavior. *Frontiers in Public Health, 13,* Article ID: 1629046. https://doi.org/10.3389/fpubh.2025.1629046

Gallardo, A., Edo-Alcón, N., Carlos, M., & Renau, M. (2016). The Determination of Waste Generation and Composition as an Essential Tool to Improve the Waste Management Plan of a University. *Waste Management, 53,* 3-11. https://doi.org/10.1016/j.wasman.2016.04.013

Gbogbo, S., Wuresah, I., Axame, W., Klutse, P., Gbogbo, E., Dowou, R. K. et al. (2025). Menstrual Blood and Ritual Beliefs: A Qualitative Study on Menstrual Health and Hygiene Practices among Senior High School Girls in Volta Region, Ghana. *Reproductive Health, 22,* Article No. 69. https://doi.org/10.1186/s12978-025-02024-y

Grodzińska-Jurczak, M. (2003). The Relation between Education, Knowledge and Action for Better Waste Management in Poland. *Waste Management & Research: The Journal for a Sustainable Circular Economy, 21,* 2-18. https://doi.org/10.1177/0734242x0302100102

Gyimah, P., Mariwah, S., Antwi, K. B., & Ansah-Mensah, K. (2021). Households' Solid Waste Separation Practices in the Cape Coast Metropolitan Area, Ghana. *GeoJournal, 86,* 567-583. https://doi.org/10.1007/s10708-019-10084-4

Hannan, M. A., Abdulla Al Mamun, M., Hussain, A., Basri, H., & Begum, R. A. (2015). A Review on Technologies and Their Usage in Solid Waste Monitoring and Management Systems: Issues and Challenges. *Waste Management, 43,* 509-523. https://doi.org/10.1016/j.wasman.2015.05.033

Hartwig, K. A., Pham, K., & Anderson, E. (2004). From the Schools of Public Health. *Public Health Reportsr, 119,* 102-109. https://doi.org/10.1177/003335490411900118

Henyo, I. K., Owusu-Addo, A., Blewu, G. A., Opoku-Manu, M., & Owusu, A. Y. (2024). Sanitation Culture among Students: Evidence from a Senior High School in Ghana. *Canadian Journal of Educational and Social Studies, 4,* 19-37.

Ho, C., & Chen, M. (2018). *Waste Management, 71,* 578-588. https://doi.org/10.1016/j.wasman.2017.09.029

Ishawu, M., Guangyu, C., Adzimah, E. D., & Mohammed Aminu, A. (2020). Achieving

Value for Money in Waste Management Projects: Determining the Effectiveness of Public-Private Partnership in Ghana. *International Journal of Managing Projects in Business, 13,* 1283-1309. https://doi.org/10.1108/ijmpb-02-2020-0060

Jayaraman, A., Tripathi, S., & Ramakrishnan, S. (2026). Regulatory Concerns for Solid Waste Management. In P. Singh, P. Agarwal, & V. Vivekanand (Eds.), *Solid Waste Management: Challenges, Sustainability and Advancements* (pp. 397-430). Wiley-Scrivener.

Jimmy, A. A. (2025). *Trash to Treasure: Sustainable Solutions to Textile Waste Management*. Doctoral Dissertation, St. Teresa's College (Autonomous) Ernakulam.

Jørgensen, N. J., Madsen, K. D., & Læssøe, J. (2018). Waste in Education: The Potential of Materiality and Practice. *Environmental Education Research, 24,* 807-817. https://doi.org/10.1080/13504622.2017.1357801

Kamanga, T. W., Chitete, M. M., Kamanga, B. C., Damazio, C., Yafeti, Y., & Sibande, M. (2024). Towards Sustainable Solid Waste Management Systems: Empirical Evidence from Northern Malawi. *Environmental Health Insights, 18*. https://doi.org/10.1177/11786302241255800

Karabulut, T., & Manga, M. (2025). Comparative Analysis of Brazil-Russia-India-China-Southafrica-Turkiye in Terms of Environmental Pollution Indicators Using Multi Criteria Decision Making Methods. *International Journal of Energy and Water Resources, 9,* 2755-2770. https://doi.org/10.1007/s42108-025-00419-y

Kashif, M., Zarkada, A., & Ramayah, T. (2018). The Impact of Attitude, Subjective Norms, and Perceived Behavioural Control on Managers' Intentions to Behave Ethically. *Total Quality Management & Business Excellence, 29,* 481-501. https://doi.org/10.1080/14783363.2016.1209970

Kofi, A. S., Kwame, B. M., Kwabena, A. W., Francis, G. S., Christopher, A., Richard, A. K. et al. (2023). Challenges of Public Participation in Solid Waste Management at Nkanfoa Landfill Site in the Cape Coast Municipality of Ghana. *Journal of Sustainable Development, 16,* 63. https://doi.org/10.5539/jsd.v16n5p63

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why Do People Act Environmentally and What Are the Barriers to Pro-Environmental Behavior? *Environmental Education Research, 8,* 239-260. https://doi.org/10.1080/13504620220145401

Kumar, A., Kumar, Y., Kumari, A., & Kumar, S. (2024). IoT-Enabled Systems for E-Waste Monitoring and Recycling. In A. Gupta, *et al.* (Eds.), *Integrated Waste Management: A Sustainable Approach from Waste to Wealth* (pp. 375-394). Springer. https://doi.org/10.1007/978-981-97-0823-9_18

Kusi-Appiah, M., Murphy, R. J., & Liu, L. (2025). An Analysis of Municipal Solid Waste Management in Ghana: A Scoping Review of Challenges, Opportunities, and Technology Options. *Sustainability, 17,* Article No. 8266. https://doi.org/10.3390/su17188266

Kyere, R., Addaney, M., & Ayaribilla Akudugu, J. (2019). Decentralization and Solid Waste Management in Urbanizing Ghana: Moving beyond the Status Quo. In *Municipal Solid Waste Management*. IntechOpen. https://doi.org/10.5772/intechopen.81894

Larbi, L., Heve, W. K., Amfo-Otu, R., Lente, I., Kumi-Amoah, G., Owusu-Twum, M. Y. et al. (2024). Students' Perceptions and Inclination towards Solid Waste Segregation for Circular Economy in Krobo Municipalities of Ghana: Awareness, Willingness and Potential Determinants. *Journal of Material Cycles and Waste Management, 26,* 3621-3630. https://doi.org/10.1007/s10163-024-02068-5

Liao, C., & Li, H. (2019). Environmental Education, Knowledge, and High School Students' Intention toward Separation of Solid Waste on Campus. *International Journal of Environmental Research and Public Health, 16,* Article No. 1659. https://doi.org/10.3390/ijerph16091659

M'nkubitu, E. (2022). *Rethinking Organic Municipal Solid Waste Management in Kenyan Urban Areas*. IIIEE Master Thesis, The International Institute for Industrial Environmental Economics. http://lup.lub.lu.se/student-papers/record/9096637

McKenzie, J., Ralabate Doody, K., Montague, M. L., Mason, H., & Morgan, J. M. (2025). Implementation of Community-Based Service Learning in Special Education Teacher Preparation Programs. *Journal of Special Education Preparation, 5,* 28-37. https://doi.org/10.33043/w6g9339hfcm

Mensah, J. (2019). Improving Environmental Sanitation in the Catchment Area of Benya Lagoon, Ghana: The Non-Household Stakeholder Role and Participation Dimension. *Journal of Water, Sanitation and Hygiene for Development, 9,* 714-730. https://doi.org/10.2166/washdev.2019.024

Moh, Y., & Abd Manaf, L. (2017). Solid Waste Management Transformation and Future Challenges of Source Separation and Recycling Practice in Malaysia. *Resources, Conservation and Recycling, 116,* 1-14. https://doi.org/10.1016/j.resconrec.2016.09.012

Morara, M., Djongana, C., & Awuor, Q. (2023). Effectiveness of Mass Media in Creating Public Awareness on Proper Solid Waste Management: A Case of Kawangware, Nairobi County. *African Multidisciplinary Journal of Research, 1,* 231-248. https://doi.org/10.71064/spu.amjr.1.1.200

Mpuangnan, K. N., Mhlongo, H. R., & Govender, S. (2023). Managing Solid Waste in School Environment through Composting Approach. *Journal of Integrated Elementary Education, 3,* 34-57. https://doi.org/10.21580/jieed.v3i1.16003

Mushi, B. (2024). Willingness to Pay for Sustainable Solid Waste Management in Dodoma Urban District, Tanzania. *Journal of Policy and Development Studies, 17,* 181-198. https://doi.org/10.4314/jpds.v17i1.15

Njau, S. T., Onyango, G., & Itegi, F. (2024). Waste Management Practices and Effect on Teaching and Learning in Public Secondary Schools in Nairobi and Kajiado Counties, Kenya. *Environment and Ecology Research, 12,* 492-501. https://doi.org/10.13189/eer.2024.120503

Nuruzzaman, M., Shathi, A. S., Yousuf, A., Islam, M. J., Rana, M. S., Alam, M. S. et al. (2025). Composite Materials from Waste Plastics: A Sustainable Approach for Waste Management and Resource Utilization. *Polymers and Polymer Composites, 33*. https://doi.org/10.1177/09673911251318542

Omole, D. O., Isiorho, S. A., & Ndambuki, J. M. (2016). *Waste Management Practices in Nigeria: Impacts and Mitigation*.

Osei-Bonsu, R. (2026). Towards Zero Waste; Assessing Innovative Waste Management Practices in Senior High Schools in Ghana. *Advances in Earth and Environmental Science, 7,* 1-10. https://doi.org/10.47485/2766-2624.1085

Owojori, O. M., Mulaudzi, R., & Edokpayi, J. N. (2022). Student's Knowledge, Attitude, and Perception (KAP) to Solid Waste Management: A Survey towards a More Circular Economy from a Rural-Based Tertiary Institution in South Africa. *Sustainability, 14,* Article No. 1310. https://doi.org/10.3390/su14031310

Owusu-Ansah, P., Obiri-Yeboah, A. A., Nyantakyi, E. K., Woangbah, S. K., & Yeboah, S. I. I. K. (2022). Ghanaian Inclination towards Household Waste Segregation for Sustainable Waste Management. *Scientific African, 17,* e01335. https://doi.org/10.1016/j.sciaf.2022.e01335

Palamuleni, L. G. (2002). Effect of Sanitation Facilities, Domestic Solid Waste Disposal and Hygiene Practices on Water Quality in Malawi's Urban Poor Areas: A Case Study of South Lunzu Township in the City of Blantyre. *Physics and Chemistry of the Earth, Parts A/B/C, 27,* 845-850. https://doi.org/10.1016/s1474-7065(02)00079-7

Papka, I. M., Ndagiya, A. I., Umar, M. M., & Mala, S. M. (2025). Understanding Community Knowledge, Attitudes, and Practices: A Narrative Review for Designing Context-Specific Interventions to Control Transmission and Reduce Disease Burden. *SSR Journal of Medical Sciences, 2,* 40-50.

Perkins, D. N., Drisse, M. N. B., Nxele, T., & Sly, P. D. (2014). E-Waste: A Global Hazard. *Annals of Global Health, 80,* 286-295. https://doi.org/10.1016/j.aogh.2014.10.001

Pillay, M. (2005). *Knowledge, Attitude and Practices (KAP) Survey*. Doctoral Dissertation, Stellenbosch University. http://hdl.handle.net/10019.1/50388

Pires, A., Martinho, G., Rodrigues, S., & Gomes, M. I. (2019). *Sustainable Solid Waste Collection and Management*. Springer.

Rahmania, T. (2024). Exploring School Environmental Psychology in Children and Adolescents: The Influence of Environmental and Psychosocial Factors on Sustainable Behavior in Indonesia. *Heliyon, 10,* e37881. https://doi.org/10.1016/j.heliyon.2024.e37881

Rickinson, M. (2001). Learners and Learning in Environmental Education: A Critical Review of the Evidence. *Environmental Education Research, 7,* 207-320. https://doi.org/10.1080/13504620120065230

Roleola, O. O., & Jolaoso, M. A. (2025). Promoting Sustainability in Nigerian Education: A Practical Study on Reducing Paper Waste through ICT and New Media Innovations. *Nigerian Journal of Technical Education, 24,* 19-30. https://doi.org/10.63996/njte.v24i2.35

Roy, N., Manaf, L. A., & Ramli, A. H. M. (2025). Socio-Cultural Drivers of Waste Management Practices: A KAP-Based Systematic Review with Lessons from Dhaka and Diverse Urban Contexts. *Waste Management Bulletin, 3,* Article ID: 100251. https://doi.org/10.1016/j.wmb.2025.100251

Safo-Adu, G., & Owusu-Adzorah, N. (2023). Solid Waste Characterisation and Recycling Potential: A Study in Secondary Schools in Kumasi Metropolis, Ghana. *Cleaner Waste Systems, 4,* Article ID: 100065. https://doi.org/10.1016/j.clwas.2022.100065

Salleh, N. A., Mohd Zahari, F., Othman, Z., Abu, N. H., Hashim, R., & Mohd Nawi, M. N. (2020). Sustainable Solid Waste Management Knowledge and Practices among Rural Community in Malaysia. *International Journal of Advanced Science and Technology, 29,* 1951-1956. https://repo.uum.edu.my/id/eprint/27214

Sarfo-Mensah, P., Obeng-Okrah, K., Arhin, A. A., Amaning, T. K., & Oblitei, R. T. (2019). Solid Waste Management in Urban Communities in Ghana: A Case Study of the Kumasi Metropolis. *African Journal of Environmental Science and Technology, 13,* 342-353. https://doi.org/10.5897/ajest2019.2713

Sarpong-Anane, A. B. (2015). *Public Perceptions, Attitudes and Challenges towards Solid Waste Management in Ghana: The Case of Mamobi Community*. Doctoral Dissertation, University of Ghana. https://afribary.com/works/public-perceptions-attitudes-and-challenges-towards-solid-waste-management-in-ghana-the-case-of-mamobi-community/read

Shah, S. S., & Asghar, Z. (2024). Individual Attitudes towards Environmentally Friendly Choices: A Comprehensive Analysis of the Role of Legal Rules, Religion, and Confidence in Government. *Journal of Environmental Studies and Sciences, 14,* 629-651. https://doi.org/10.1007/s13412-024-00913-5

Smyth, D. P., Fredeen, A. L., & Booth, A. L. (2010). Reducing Solid Waste in Higher Education: The First Step towards "Greening" a University Campus. *Resources, Conservation and Recycling, 54,* 1007-1016. https://doi.org/10.1016/j.resconrec.2010.02.008

Stromquist, N. P. (2005). Comparative and International Education: A Journey toward Equality and Equity. *Harvard Educational Review, 75,* 89-111.

https://doi.org/10.17763/haer.75.1.4842626v0r385j12

Swesi, A. E. M., Mallak, S. K., & Tendulkar, A. (2019). Community Attitude, Perception and Willingness towards Solid Waste Management in Malaysia, Case Study. *Journal of Wastes and Biomass Management, 1,* 9-14. https://doi.org/10.26480/jwbm.01.2019.09.14

Takyi, B., Bordoh, A., Eshun, I., & Owusu, F. (2025). Global Citizenship Education in Ghana: An Evaluation of the Junior High School Social Studies Curriculum. *Journal of Educational Research and Practice, 15,* Article No. 31. https://doi.org/10.5590/jerap.2025.15.2059

Twumasi, A. (2017). Awareness and Practice of Solid Waste Management in the Winneba Municipality of Ghana. *European Journal of Earth and Environment, 4,* 39-47.

Uzodianya, D. M. (2026). Evaluation of Sustainable Waist Management Strategies to Reduce Plastic Pollution in Diobe Port Harcourt Rivers State. *International Journal of Research in Environmental Science and Technology, 11,* 102-133. https://mail.bwjournal.org/index.php/bsjournal/article/view/3773

Valavanidis, A. (2023). *Global Municipal Solid Waste (MSW) in Crisis. Two Billion Tonnes of MSW Every Year, a Worrying Worldwide Environmental Problem.* 1-28.

Verplanken, B., & Orbell, S. (2022). Attitudes, Habits, and Behavior Change. *Annual Review of Psychology, 73,* 327-352. https://doi.org/10.1146/annurev-psych-020821-011744

Wehn, U., & Almomani, A. (2019). Incentives and Barriers for Participation in Community-Based Environmental Monitoring and Information Systems: A Critical Analysis and Integration of the Literature. *Environmental Science & Policy, 101,* 341-357. https://doi.org/10.1016/j.envsci.2019.09.002

Wojnowska-Baryła, I., Bernat, K., Zaborowska, M., & Kulikowska, D. (2024). The Growing Problem of Textile Waste Generation—The Current State of Textile Waste Management. *Energies, 17,* Article No. 1528. https://doi.org/10.3390/en17071528

Zand, A. D., Heir, A. V., & Khodaei, H. (2022). A Survey of Knowledge, Attitudes, and Practices of Tehran Residents Regarding Solid Waste Management in the COVID-19 Era. *Journal of Hazardous Materials Advances, 8,* Article ID: 100203. https://doi.org/10.1016/j.hazadv.2022.100203

Zohoori, M., & Ghani, A. (2017). Municipal Solid Waste Management Challenges and Problems for Cities in Low-Income and Developing Countries. *International Journal of Science and Engineering Applications, 6,* 39-48. https://doi.org/10.7753/ijsea0602.1002

Zsóka, Á., Szerényi, Z. M., Széchy, A., & Kocsis, T. (2013). Greening Due to Environmental Education? Environmental Knowledge, Attitudes, Consumer Behavior and Everyday Pro-Environmental Activities of Hungarian High School and University Students. *Journal of Cleaner Production, 48,* 126-138. https://doi.org/10.1016/j.jclepro.2012.11.030