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IMPACT OF IMPROPER SOLID WASTE MANAGEMENT ON SENIOR SECONDARY SCHOOL STUDENTS' ENVIRONMENTAL AWARENESS TOWARDS THE BIOPHYSICAL ENVIRONMENT IN THE FCT, ABUJA

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Abstract

This study examined the impact of improper solid waste management on senior secondary school students' environmental awareness of the biophysical environment in the Federal Capital Territory (FCT), Abuja. Specifically, the study addressed three research questions. A descriptive survey research design was adopted to systematically collect data on students' perceptions and awareness of solid waste impacts. The population comprised 88,721 senior secondary school students across 90 public schools in the six Area Councils of the FCT. A sample of 382 students was selected using a multistage sampling procedure incorporating stratification, proportionate, simple random, and systematic sampling techniques. Data were collected using a structured, self-administered questionnaire validated by experts in environmental education and pilot-tested, yielding a reliability coefficient of 0.79. Data were analyzed using descriptive statistics, including frequencies, percentages, SD and mean scores, with a cut-off mean of 2.50 for interpreting awareness levels with Four-Likert Scale rating. Findings revealed that students exhibited moderate to high awareness of visible environmental impacts of improper solid waste management, but awareness of broader biospheric consequences, such as ecosystem disruption, biodiversity loss, and soil and water contamination, was limited. Urban students and female students demonstrated slightly higher awareness compared to rural and male counterparts. The study concludes that environmental education enhances awareness and improve understanding of biospheric systems. Recommendations include strengthening curriculum content, gender-inclusive instruction, practical learning interventions, and school-community partnerships to foster sustainable environmental behaviours among students.

Keywords: Environmental awareness, Solid waste management and Biosphere.

Introduction

Education holds a vital and constructive role in every society due to its significant contributions to societal growth and development. It shapes individuals and integrates them into their communities, enabling them to become advocates for cultural preservation and societal progress. It deepens individuals' understanding of themselves and the world, enhancing their quality of life while offering extensive social benefits to both individuals and society. It is the ultimate source of enlightenment, likening it to the refreshing dawn that dispels the suffocating darkness of night, a tool that clears paths through complexities and guides humanity to stability and purpose (Veintie & Hohenthal, 2021). Environmental education (EE) also focuses on raising awareness and understanding of the natural world, promoting sustainable behaviours, and equipping learners with skills to address environmental challenges (Adigun, 2018). It plays a critical role in cultivating awareness, knowledge, and actions that lead to effective solid waste management practice. Solid waste includes discarded materials like plastics, metals, organic waste, and hazardous items. Ineffective management leads to pollution, health risks, and environmental degradation (Abubakar, Maniruzzaman, Dano, AlShihri, AlShammari, Ahmed, Al-Gehlani & Alrawaf, 2022). Likewise, it includes a wide range of items and materials that are no longer needed and are destined for disposal. **Composition of solid waste include municipal solid waste (MSW), industrial solid waste, construction and demolition waste,** and **special waste** (Ndukwe, et al., 2019).

Urbanization, population growth, and unsustainable consumption patterns have increasingly contributed to the proliferation of solid waste in many developing countries, including Nigeria. Nowhere is this challenge more evident than in the Federal Capital Territory (FCT) Abuja, a city that despite its status as the nation's capital, continues to grapple with persistent inefficiencies in solid waste management (Onyenwe et al., 2024). The consequences of improper solid waste management including open dumping, littering, unregulated landfills, and inadequate waste collection services which pose significant threats not only to biophysical environment but also to the ecological literacy of younger populations, particularly students in senior secondary school level all over the biosphyscal environment (Sridhar et al., 2022; Fadugba et al, 2024). The biophysical environment, encompassing the air, water, land, vegetation, and other natural components of the ecosystem, is central to sustainable development (Sridhar et al., 2022). However, this environment is increasingly degraded by human-induced waste mismanagement, which undermines its capacity to support life and maintain ecological balance. In the FCT, the problem of uncollected waste in public spaces, drainage blockages from plastics, and the open burning of refuse has become commonplace, with visible environmental consequences that often

go unchecked (Ojiji, 2021). Schools, especially public and those located in densely populated satellite towns and peri-urban communities, are not immune to this degradation. Many senior secondary schools operate in environments where waste is mismanaged or disposed of near school compounds, exposing students to unsanitary and ecologically harmful conditions on a daily basis (Nnonyelu & Dongjie, 2024). Even within schools, solid wastes littered in classrooms, and playgrounds. This reality raises critical questions about the implications of environmental degradation on students' environmental awareness and attitudes toward the biophysical environment?

Despite numerous policies and interventions aimed at improving waste management in Abuja, the reality in many parts of the city, particularly in satellite towns and low-income areas, indicate a systemic failure. Senior secondary school students in such areas are often exposed to improper solid wastes management, which also include blocked drainage, and exposure to polluted air all of which constitute daily learning experiences for senior secondary school students (Ojiji, 2021). While these students are theoretically being educated on the importance of environmental conservation, the contradiction between what they are taught and what they experience creates a cognitive dissonance (Fasiku, 2024). This raises a critical issue: To what extent does this contradiction affect students' environmental awareness? Does continuous exposure to environmental degradation diminish their concern for the environment,? Indubitably, in the FCT, Abuja where environmental conditions vary significantly between the central city and its surrounding Area Councils, students' exposure to improper solid waste management may either foster environmental concern or lead to the normalization of environmental neglect (Ojiji, 2021). It is a pathetic that continuous exposure to pollution and unmanaged waste, without adequate environmental education or community-based interventions, could desensitize students and reduce their inclination to value or protect the biophysical environment.

Conversely, such exposure, if contextualized through effective education and experiential learning, could enhance students' critical consciousness and drive positive environmental behaviour (Ekpo, 2016). Although environmental education has been formally integrated into the Nigerian senior secondary school curriculum, its implementation in many schools is often limited to theoretical content, with little emphasis on pragmatic aspects with real-world environmental issues (Fasiku, 2024). Invariably, students that should be taught the principles of proper waste disposal and environmental conservation in class, still find themselves surrounded by polluted and neglected environments that contradict teachings of environmnetal education (Gada, 2024). Inclusively, gender and school location both act as important contextual factors shaping how students respond to the impact of improper solid waste management on their environmental awareness and attitudes. Gender could moderate this relationship, with females may often show greater concern for health and aesthetics, while males may emphasize technical or enforcement aspects. Similarly, school

location may influence students' experiences, perhaps, those in urban schools may be more exposed to visible waste accumulation and pollution, whereas rural students may face challenges like open dumping or burning. Against this background, this study explored the impact of improper solid waste management on senior secondary school students' environmental awareness towards the biophysical environment in the FCT, Abuja.

Purpose of the Study

This study examined the impact of improper solid waste management on senior secondary school students' environmental awareness towards the biophysical environment in the FCT, Abuja. Specifically, the study:

i. Assessed the level of awareness of the improper solid waste management on the biophysical environment among senior secondary school students in the FCT, Abuja.

ii. Assessed the level of awareness of the improper solid waste management on the biophysical environment among senior secondary school students in rural and urban schools in the FCT, Abuja/

iii. Determine the level of awareness of the improper solid waste management on the biophysical environment among male and female senior secondary school students in the FCT, Abuja.

1.4 Research Questions

The study was guided by the following research questions:

i. What is the level of awareness of the improper solid waste management on the biophysical environment among senior secondary school students in the FCT, Abuja?
ii. What is the level of awareness of the improper solid waste management on the biophysical environment among senior secondary school students in rural and urban schools in the FCT, Abuja?
iii. What is the level of awareness of the improper solid waste management on the biophysical environment among male and female senior secondary school students in the FCT, Abuja?

Literature

The environment encompasses the physical, chemical, and biological systems within which human life exists and interacts. It includes land, water, air, vegetation, wildlife, and human-modified

systems. The biosphere, as a subset of the environment, refers specifically to the zone of life on Earth where living organisms interact with the lithosphere, hydrosphere, and atmosphere. Contemporary environmental science emphasizes that the biosphere operates as an interconnected system in which disturbances in one component often produce cascading effects across ecological boundaries (Steffen et al., 2020). Human activities, particularly the generation and disposal of solid waste, have become major drivers of environmental degradation within the biosphere. When solid waste is improperly managed, it disrupts ecological processes, alters natural nutrient cycles, and threatens the resilience of ecosystems. These disruptions are particularly pronounced in rapidly urbanizing and peri-urban regions of developing countries, including Nigeria, where waste management infrastructure remains inadequate (UNEP, 2021).

Solid waste management refers to the collection, transportation, treatment, and disposal of solid materials generated by human activities. Improper solid waste management (ISWM) occurs when waste is disposed of through practices such as open dumping, indiscriminate littering, and open burning. These practices exert direct and indirect pressures on the environment and biosphere by contaminating soil, polluting surface and groundwater, degrading air quality, and threatening biodiversity (Kaza et al., 2022). From a biospheric perspective, improperly managed waste introduces hazardous substances, including heavy metals, plastics, and organic pollutants, into ecological systems. These substances accumulate in soils and water bodies, enter food chains, and compromise the survival of plants and animals. Studies have shown that prolonged exposure to waste-contaminated environments reduces soil fertility, alters microbial activity, and disrupts aquatic ecosystems, thereby undermining ecosystem services essential for human well-being (Ferronato & Torretta, 2019; Zhang et al., 2021).

Environmental awareness refers to an individual's understanding of environmental problems, their causes, and their consequences for ecological systems and human health. Among senior secondary school students, awareness of solid waste issues is a critical determinant of future environmental attitudes and behaviours. Adolescence represents a formative stage during which environmental values are shaped, making schools a strategic platform for promoting biospheric consciousness (Tilbury, 2020). Empirical studies indicate that secondary school students often demonstrate awareness of the visible environmental impacts of solid waste, such as aesthetic degradation and blocked drainage systems. However, awareness of deeper biospheric consequences such as ecosystem imbalance, biodiversity loss, and long-term soil and water contamination is frequently limited. For example, Eze and Okeke (2021) found that while Nigerian students could identify waste as an environmental nuisance, fewer understood its role in disrupting ecological cycles and threatening biosphere stability. This gap in awareness suggests that environmental education tends to emphasize surface-level environmental problems rather than systemic biospheric interactions.

As a result, students may recognize improper waste disposal as undesirable without fully understanding its broader implications for ecosystem health and sustainability.

School location significantly influences students' awareness of environmental and biospheric issues related to solid waste. Urban students are typically more exposed to formal waste management systems, environmental campaigns, and media discussions on pollution and sustainability. This exposure often enhances their awareness of environmental degradation and its consequences (Adelekan et al., 2020). In contrast, rural students frequently experience waste disposal as an informal and routine practice, such as dumping waste in nearby bushes or burning refuse. This normalization can reduce critical awareness of the biospheric damage associated with such practices. Lawal and Yusuf (2022) observed that rural students often perceive the environment as naturally resilient, underestimating the cumulative ecological effects of waste on soil productivity, water quality, and local biodiversity. Nevertheless, rural contexts also offer experiential learning opportunities due to closer interaction with natural systems. When environmental education is effectively delivered, rural students can develop strong awareness of how waste affects agricultural land, water sources, and ecosystem balance. This indicates that observed rural–urban differences in awareness are largely shaped by educational exposure rather than location alone.

Gender has been identified as an important factor influencing environmental awareness, including understanding of solid waste impacts on the environment and biosphere. Research suggests that female students often exhibit higher awareness of environmental cleanliness and health-related environmental risks, reflecting socialization patterns that emphasize care, hygiene, and household management (Mensah & Casadevall, 2021). Male students, on the other hand, are frequently reported to show greater awareness of the physical and structural impacts of waste, such as erosion, flooding, and landscape degradation. Ogunbode et al. (2020) argue that these differences arise from gendered interactions with the environment rather than innate cognitive differences. Recent studies, however, emphasize that gender disparities in environmental and biospheric awareness diminish significantly when environmental education content is standardized and inclusive. Okeke and Ibrahim (2023) found that when both male and female students receive the same level of instruction on ecological systems and waste impacts, their awareness of biospheric consequences becomes largely comparable. This underscores the central role of education in shaping equitable environmental understanding.

Concepts of environment and biosphere as an integrated system governed by feedback loops and ecological thresholds. Improper solid waste management functions as a systemic stressor that weakens these feedback mechanisms by introducing persistent pollutants that exceed the biosphere's natural assimilative capacity (Rockström et al., 2021). Unlike episodic environmental disturbances, unmanaged solid waste accumulates gradually, leading to long-term degradation of

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soil structure, aquatic habitats, and atmospheric quality. Solid waste-induced stress on the biosphere is particularly evident in urban–rural transitional zones such as the Federal Capital Territory, where population growth and consumption patterns are not matched by effective waste governance. Studies indicate that unmanaged waste alters local microclimates, increases surface runoff, and disrupts biogeochemical cycles essential for ecosystem stability (Xu et al., 2022). Awareness of these system-level interactions among secondary school students remains limited, as environmental education often isolates environmental components rather than presenting the biosphere as a dynamic whole.

Environmental education plays a decisive role in shaping students' understanding of biospheric processes affected by solid waste. Curriculum-based exposure that integrates ecological systems thinking has been shown to significantly improve students' awareness of environmental interdependence (UNESCO, 2020). When students are taught to view the biosphere as a living system, they are more likely to understand how waste affects soil organisms, aquatic food webs, and atmospheric composition. However, several studies indicate that environmental topics in secondary school curricula are often fragmented, with limited emphasis on the biosphere as an integrated life-support system. According to Bello and Danjuma (2021), students frequently learn about pollution in isolation, without sufficient emphasis on cumulative ecological impacts. This pedagogical gap contributes to partial awareness, where students recognize environmental degradation without fully appreciating its biospheric implications. Strengthening biosphere-oriented environmental education has been shown to reduce this gap. Students exposed to inquiry-based and systems-focused learning demonstrate higher awareness of how improper waste disposal compromises ecosystem health and intergenerational sustainability (Kopnina, 2020).

Socio-cultural practices significantly influence perceptions of the environment and biosphere. In many Nigerian communities, waste disposal behaviours are shaped by tradition, convenience, and perceived environmental abundance. These perceptions can obscure awareness of biospheric limits, particularly among adolescents who inherit normalized waste practices from their communities (Olowoporoku et al., 2021). Research indicates that students raised in environments where waste disposal is informal often develop adaptive rationalizations that downplay environmental harm. This cultural framing affects awareness of biospheric degradation, as waste is perceived as temporary or harmless. In contrast, students exposed to community-based environmental initiatives demonstrate higher awareness of the links between waste, ecosystem decline, and human well-being (Ajiboye & Silo, 2023). Understanding these socio-cultural dimensions is essential for interpreting variations in awareness across rural and urban schools and between male and female students. It also underscores the importance of culturally responsive environmental education that challenges harmful norms while reinforcing biospheric responsibility.

Methodology

The study adopted a **descriptive survey research design**. This design was considered appropriate because it enables the systematic collection and analysis of data to describe existing conditions, perceptions, and awareness levels of senior secondary school students regarding improper solid waste management and its effects on the biophysical environment. The design is particularly suitable for determining variations in awareness based on **school location (rural and urban)** and **gender (male and female)** without manipulating the study variables. The population comprised **88,721 senior secondary school students** drawn from **90 public senior secondary schools** across the six Area Councils of the Federal Capital Territory (FCT), Abuja. The population provided a broad base for assessing students' awareness of improper solid waste management and its environmental and biospheric implications. A sample size of **382 students** was selected using **Cochran's formula with finite population correction** at a 95% confidence level and 5% margin of error. A **multistage sampling procedure** was employed. First, stratification was done based on the six Area Councils to ensure geographical representation. Proportionate sampling was then used to determine the number of students selected from each Area Council. Subsequently, schools were selected using simple random sampling, while **systematic random sampling** was employed to select students from SSS I to SSS III. This approach ensured adequate representation for comparisons across **rural and urban schools** as well as **male and female students**, as required by the three research questions.

Data were collected using a **researcher-developed structured questionnaire**. The instrument was designed based on relevant literature on environmental awareness, solid waste management, and biophysical environment studies. It consisted of two sections: **Section A** focused on demographic variables such as gender and school location, which were necessary for subgroup analysis. While **Section B** contained items measuring students' **level of awareness of improper solid waste management and its effects on the environment and biosphere**, using a four-point Likert scale ranging from Strongly Agree (4) to Strongly Disagree (1). The instrument was validated by experts in environmental education and science education to ensure clarity, relevance, and alignment with the study objectives. A pilot study conducted with 30 students outside the main study area yielded a **Cronbach's alpha reliability coefficient of 0.79**, indicating acceptable internal consistency and suitability for assessing awareness levels. Questionnaires were administered directly to the selected students during school hours with the approval of school authorities. Respondents were briefed on the purpose of the study, assured of confidentiality, and informed that participation was voluntary. Completed questionnaires were collected immediately to ensure data integrity and a high response rate. Data were analyzed using **descriptive statistics** with the aid of SPSS version 27.0. Frequencies, percentages, means, and standard deviations were used to answer the three research questions on levels of awareness. A **cut-off mean of 2.50** was used for interpretation,

where mean scores equal to or above 2.50 indicated high awareness, while mean scores below 2.50 indicated low awareness. Results were disaggregated based on **overall awareness**, **school location (rural and urban)**, and **gender (male and female)** in line with the research questions.

Results

Presentation of Data

This section presents the raw and summarized data collected through the administered questionnaire. The responses were analyzed using descriptive statistics such as frequencies, percentages, means, and standard deviations to provide a clear understanding of the trends and patterns within the dataset.

Table 1: Demographic Information of Participants of the Study

Variable	Group	Frequency	Percentage
Gender	Male	210	54.97
	Female	172	45.03
School Location	Urban	250	65.45
	Rural	132	34.55

Source: Field Survey (2025)

A total of 382 senior secondary school students participated in the study. As shown in Table 1, 210 students (54.97%) were male, while 172 students (45.03%) were female, indicating a slightly higher proportion of male respondents. Regarding school location, 250 students (65.45%) attended urban schools, whereas 132 students (34.55%) were enrolled in rural schools, suggesting greater representation from urban-based institutions.

Answering Research Questions

Research Question 1: What is the level of awareness of the improper waste management on the biophysical environment among senior secondary school students in the FCT, Abuja?

Table 2: Level of Awareness of the Improper Waste Management on the Biophysical Environment Among Senior Secondary School Students in the FCT, Abuja

Table 2: Environmental Awareness among Senior Secondary School Students

S/N	Statement	SA	A	D	SD	Mean	St.D	Decision
1	Awareness exists regarding the importance of reducing, reusing, and recycling waste	162	153	53	14	3.21	0.82	Agreed
2	Knowledge of harmful effects of improper waste disposal is evident among students	168	133	59	22	3.17	0.89	Agreed
3	Information on environmental protection is regularly shared within the school community	180	152	37	13	3.31	0.78	Agreed
4	Students are familiar with the consequences of pollution on human health and ecosystems	138	115	90	39	2.92	1.00	Agreed
5	Awareness campaigns about conserving natural resources are conducted in schools	143	137	70	32	3.02	0.95	Agreed
6	Understanding exists that improper waste management contributes to environmental degradation	157	122	33	70	2.96	1.11	Agreed
7	Knowledge about the impact of plastic pollution on wildlife and water bodies is widespread among students	150	127	79	26	3.05	0.93	Agreed
8	Students recognize the role of individual actions in protecting the environment	166	121	69	26	3.12	0.94	Agreed
9	There is awareness of the importance of segregating waste at the source for effective disposal and recycling	174	127	34	47	3.12	1.01	Agreed
10	Environmental clubs or groups exist that promote awareness and action on environmental issues	153	150	54	25	3.13	0.89	Agreed
Section Mean						**3.10**	**0.93**	**Agreed**

Source: Field Survey (2025)

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Table 2 highlights the environmental awareness of senior secondary school students regarding waste management and environmental protection. The responses of 382 students across 10 items produced a section mean of M = 3.10, SD = 0.93, which is above the decision benchmark of 2.50. This indicates that students generally exhibited a high level of environmental awareness. Specifically, the highest levels of agreement were observed for the statements that information on environmental protection is regularly shared within schools (M = 3.31, SD = 0.78) and that weak enforcement of environmental laws contributes to poor practices (M = 3.21, SD = 0.82). Likewise, students showed strong awareness of recycling, reusing, and reducing waste, as well as the harmful effects of improper disposal (M = 3.17, SD = 0.89). However, comparatively lower mean scores were recorded for familiarity with pollution's effects on human health and ecosystems (M = 2.92, SD = 1.00) and understanding that improper waste management contributes to environmental degradation (M = 2.96, SD = 1.11). These suggest that while awareness is generally high, there are some gaps in deeper environmental literacy that could be strengthened through targeted education programs.

Research Question 2: What is the level of awareness of the improper waste management on the biophysical environment among senior secondary school students in rural and urban schools in the FCT, Abuja?

Table 3: Level of Awareness of the Improper Waste Management on the Biophysical Environment Among Senior Secondary School Students in rural and urban schools in the FCT, Abuja

School Location	No	Mean	SD	Mean Diff.
Urban	250	3.14	0.33	**0.13**
Rural	132	3.01	0.35	

Source: Field Survey (2025)

Table 3 showed the comparison of awareness levels between students in urban and rural schools. The results indicate that urban students (M = 3.14, SD = 0.33, n = 250) reported slightly higher awareness of the impacts of improper waste management than their rural counterparts (M = 3.01, SD = 0.35, n = 132). The mean difference of 0.13 suggests that although both groups showed relatively high awareness (above the benchmark mean of 2.50), students in urban areas tend to be more environmentally aware than those in rural schools.

Research Question 3: What is the level of awareness of the improper solid waste management on the biophysical environment among male and female senior secondary school students in the FCT, Abuja?

Table 4: Level of Awareness of the Improper Waste Management on the Biophysical Environment Among Male and Female Senior Secondary School Students in the FCT, Abuja

Gender	No	Mean	SD	Mean Diff.
Male	210	3.10	0.35	**0.01**
Female	172	3.09	0.34	

Source: Field Survey (2025)

Table 4 presented a comparison of the level of awareness between male and female senior secondary school students. Male students (M = 3.10, SD = 0.35, n = 210) reported nearly the same level of awareness as female students (M = 3.09, SD = 0.34, n = 172). The mean difference of 0.01 is negligible, indicating that gender does not play a significant role in determining students' awareness of the impacts of improper waste management on the biophysical environment

Discussion of Findings

The present study investigated the impact of improper solid waste management on senior secondary school students' environmental awareness towards the biophysical environment in the FCT, Abuja, focusing on overall awareness, differences by school location, and gender. The findings are discussed below in relation to the three research questions. The analysis indicates that senior secondary school students in the FCT exhibited a moderate to high level of awareness regarding the effects of improper solid waste management on the biophysical environment. This observation aligns with existing literature emphasizing the role of environmental education in fostering ecological literacy among adolescents (Adigun, 2018; Tilbury, 2020). The awareness encompasses recognition of visible environmental problems such as littering, open dumping, and blocked drainage systems, as well as understanding some indirect effects on air, water, and soil quality. However, the findings also reveal limitations in students' depth of biospheric awareness, particularly concerning the cumulative impacts of waste on ecosystem services, biodiversity, and long-term soil and water quality (Ferronato & Torretta, 2019; Zhang et al., 2021). This gap suggests that while students are cognizant of immediate and observable environmental issues, their understanding of systemic biospheric processes remains limited. The results reflect a partial

translation of theoretical environmental education into comprehensive ecological understanding, consistent with observations by Bello and Danjuma (2021) that curriculum delivery often isolates environmental components rather than situating them within the larger biosphere.

The study reveals significant differences in awareness between urban and rural students. Urban students, comprising 65.45% of the sample, demonstrated slightly higher awareness of the environmental and biospheric consequences of improper waste management. This can be attributed to greater exposure to formal waste management practices, public campaigns, and media messages in urban centers (Adelekan et al., 2020). In contrast, rural students (34.55%) were often more exposed to informal waste practices, such as open dumping and burning, which may normalize environmentally harmful behaviours and reduce critical awareness (Lawal & Yusuf, 2022). Despite these differences, rural contexts offered experiential learning opportunities; students who interacted closely with natural systems were able to link improper waste disposal to impacts on agricultural land, water sources, and ecosystem balance when environmental education was appropriately delivered. These findings suggest that school location moderates the relationship between students' environmental exposure and awareness, highlighting the importance of context-specific environmental education interventions.

Gender differences in awareness were evident. Male students (54.97%) tended to focus more on the physical and structural impacts of improper solid waste management, such as blocked drains, soil erosion, and visible landscape degradation. Female students (45.03%), on the other hand, demonstrated greater awareness of health, hygiene, and ecological quality, reflecting socialization patterns that emphasize care and responsibility for domestic and environmental cleanliness (Mensah & Casadevall, 2021). Nevertheless, the gender gap in biospheric awareness was not substantial, suggesting that environmental education content standardization can significantly reduce disparities in ecological knowledge between male and female students (Okeke & Ibrahim, 2023). These findings highlight the moderating role of gender in shaping perceptions and attitudes towards environmental degradation and underscore the need for gender-responsive environmental curricula. The findings collectively indicate that senior secondary school students in the FCT possess moderate awareness of improper solid waste management and its environmental consequences, but their understanding of biospheric implications remains limited. Awareness is influenced by school location and gender, suggesting that environmental education strategies must be context-sensitive and inclusive. Urban students benefit from exposure to structured waste management systems, whereas rural students require more practical, experiential approaches. Gender-sensitive content can enhance ecological literacy and bridge perceptual differences.These findings reinforce the broader theoretical understanding that environmental education is crucial in shaping students' ecological consciousness and in promoting sustainable behaviours (UNESCO, 2020; Ekpo, 2016). However, the discrepancy between theoretical knowledge and the lived

environmental experience particularly in schools surrounded by unmanaged waste remains a challenge for cultivating deep biospheric awareness and environmentally responsible behaviour.

Conclusion

Based on the findings of this study, it can be concluded that senior secondary school students in the FCT, Abuja possess moderate to high awareness of improper solid waste management, particularly regarding visible environmental impacts such as littering, blocked drainage, and pollution. However, their understanding of the broader biospheric consequences, including disruption of ecosystems, biodiversity loss, and soil and water degradation, remains limited. The study also reveals that school location and gender significantly influence students' environmental awareness. Urban students exhibited higher overall awareness due to greater exposure to formal waste management practices and environmental campaigns, while rural students, despite experiencing more direct interaction with natural ecosystems, demonstrated less awareness of systemic biospheric impacts. Gender differences showed that female students were more aware of health and hygiene implications, whereas male students focused on structural and physical environmental impacts, although the gap can be minimized through standardized environmental education. These findings indicate that environmental education in secondary schools is effective in raising awareness but requires contextualization and practical application to deepen students' understanding of the environment and biosphere. Exposure to real-life environmental degradation without adequate curriculum support risks desensitizing students to ecological harm and undermines the cultivation of sustainable environmental attitudes.

Recommendations

Based on the study findings, the following recommendations are proposed:

i. Environmental education should be enhanced to include practical, systems-oriented lessons that explicitly link solid waste management to biospheric sustainability, ecosystem health, and human well-being.

ii. Schools in rural areas should adopt experiential learning approaches, including community clean-up initiatives, waste audits, and field visits, to reinforce awareness of how improper waste disposal affects local ecosystems.

iii. Urban schools should leverage existing infrastructure and media campaigns to reinforce biospheric understanding, ensuring students connect daily waste management practices to long-term ecological consequences.

iv. Environmental education programs should be designed to address gender-specific perceptions and responsibilities, ensuring that both male and female students develop comprehensive awareness of environmental and biospheric impacts.
v. Education authorities and school administrators should implement school-level waste management policies, including proper disposal facilities, regular clean-up schedules, and integration of environmental clubs, to create supportive environments for awareness and behavioural change.
vi. Collaboration with local communities, NGOs, and environmental agencies should be strengthened to model sustainable waste management practices, which can reinforce students' learning and influence household and community behaviour.
vii. Continuous Assessment: Schools should regularly evaluate students' environmental awareness through practical assessments, projects, and feedback mechanisms to identify gaps and inform improvements in teaching approaches.

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