

Chemistry Students' Awareness and Application of Green Chemistry Principles in Environmental Waste Management in Higher Institutions in Akwa Ibom State

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Abstract: The study was carried out to investigate Chemistry students' awareness and application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State. This study employed a descriptive survey research design. The population of the study consisted of 1,324 Chemistry students in the nine higher institutions in Akwa Ibom State. A sample size of 300 Chemistry students was selected for the study using multistage sampling technique. The instruments used for data collection were "Awareness of Green Chemistry Principles in Environmental Waste Management Questionnaire (AWGEQ) and "Application of Green Chemistry Principles in Environmental Waste Management Questionnaire (AGEQ)". The instruments were subjected to face validity. Reliability coefficients of 0.85, and 0.82 were obtained for the AWGEQ and AGEQ, respectively using Cronbach's alpha. A total of 300 copies of the instrument were administered and 282 were correctly filled retrieved from the respondents representing 94 percent return rate. Mean and standard deviation were used to answer the research questions while independent t-test was used to test the hypotheses. The study established a high level of awareness and application of Green Chemistry principles in environmental waste management among Chemistry students in higher institutions. It also found no significant difference between male and female Chemistry students' levels of awareness and application of Green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State. It was recommended among others that, Chemistry lecturers should continue to adopt inclusive teaching and laboratory supervision strategies that engage both male and female students equally.

Keywords: Awareness, Application, Green Chemistry, Waste Management.

I. INTRODUCTION

Chemistry unravels the mysteries of matter, providing vital insights into the composition, behaviour, and transformation of our natural resources. It is not only the foundation upon which life's processes are built but also a powerful tool for rapid industrialization, technological advancement, and innovation that provides sustainability. Its applications span diverse sectors, including agriculture, medicine, and environmental science, driving innovations that have produced life-saving drugs and advanced materials (Edem, Akpan, & Udofia, 2023; Umanah & Babayemi, 2024). However, despite the great importance of Chemistry, traditional chemical practices have, at times, led to unintended environmental degradation through the generation of hazardous waste and chemical pollution. (Umanah & Udo, 2021). This duality calls for a balanced examination of how chemistry can simultaneously drive human progress and impose ecological challenges.

Transitioning from Chemistry's foundational contributions, its unintended consequences have become evident as chemical processes, while innovative, often generate environmental hazards (Umanah & Udo, 2021). For instance, industrial facilities and research laboratories can produce hazardous wastes containing heavy metals, toxic solvents, and persistent pollutants

(Akpan & Udo, 2016). This issue is further compounded in regions like Nigeria, where ineffective waste management practices worsen the impacts on ecosystems and public health (Naidu et al., 2021; Ndukwe et al., 2019). Additionally, educational institutions themselves contribute to waste generation, from paper and food scraps to chemical byproducts and plastics.

Recognizing these challenges, chemistry offers promising avenues to enhance waste management practices through recycling, composting, and the safe handling of hazardous materials (Owoyemi & Moju, 2020; Udofia & Sambo 2022). Given these pressing realities, it is imperative to rethink chemistry education. Historically, traditional curricula, which have largely focused on technical competencies, have often overlooked the environmental impacts of chemical processes (Udofia, et. al., 2017). Consequently, today's experts advocate for a more holistic approach, one that integrates green chemistry into the curriculum to cultivate environmental stewardship in future chemists.

Green Chemistry offers a proactive framework by prioritizing the design of chemical products and processes that minimize hazardous substance use at the source (Oliveira, 2024). This innovative approach not only fosters cleaner and safer methodologies but also aligns chemical innovation with the broader objectives of sustainable development. As such, embedding green chemistry principles into both research and education empowers the next generation to drive sustainable practices while safeguarding environmental health. Green Chemistry, also known as sustainable chemistry, focuses on designing chemical products and processes that minimize waste and the use of hazardous substances (Anastas & Warner, 1998; Umanah et al., 2019). Unlike conventional approaches that address pollution after it occurs, Green Chemistry emphasizes pollution prevention at the source (Auliah et al., 2018). Its twelve principles provide a framework for promoting safer, more efficient, and environmentally responsible chemical practices in both industry and education (Owoyemi & Umanah, 2019). As future professionals who will engage with chemical processes and laboratory activities, Chemistry students are expected to understand and apply these principles, particularly in managing chemical and other forms of environmental waste.

Awareness is fundamental to such application, as it provides the knowledge and understanding required to recognize environmental problems and make informed decisions about their management (Itighise et al., 2023; Klussman et al., 2022; Awoyode, 2024). Among Chemistry students, awareness of Green Chemistry principles may enhance understanding of waste prevention, pollution reduction, resource efficiency, and safer chemical processes. However, awareness does not necessarily translate into application. Green Chemistry application involves using these principles in laboratory and other educational activities to minimize waste and environmental harm (Umanah et al., 2024; Awoyode, 2024). Evidence of variations in students' and educators' awareness and application of Green Chemistry principles suggests the need to examine both dimensions.

Awoyode (2024) examined awareness and application of Green Chemistry principles among secondary school Chemistry students found a high levels of awareness and application of Green Chemistry principles, suggesting that students possessed considerable knowledge of sustainable chemical practices. Hussain (2024) assessed Green Chemistry knowledge and awareness among college students and reported a high knowledge and very high awareness of Green Chemistry, with no significant difference between urban and rural students. Similarly, Saadon and Abbood (2022), using secondary school students reported awareness of Green Chemistry concepts and found no significant gender difference in awareness.

Furthermore, Umanah, Arop and Neji (2024) examined the level of chemistry educators' awareness and utilization of green chemistry principles in tertiary institutions and its implications for environmental sustainability and reported a moderate level of chemistry educators' awareness and low level of utilization of green chemistry principles in tertiary institutions. Also, there was no significant difference in the level of male and female chemistry educators' awareness and utilization of green chemistry principles in tertiary institutions. Amoah (2022) investigated undergraduate Chemistry students' knowledge, attitudes, and practices regarding Green Chemistry principles. Although most students had heard of Green Chemistry, their knowledge and understanding were limited, highlighting the need for stronger integration of Green Chemistry into Chemistry education.

Alake (2013) similarly reported low levels of awareness, knowledge, and practice of Green Chemistry among senior secondary school students and attributed the situation partly to the limited transfer of classroom learning to real-life situations. Extending the concern to the tertiary level, Umanah et al. (2024) examined the awareness and utilization of Green Chemistry principles among Chemistry educators in tertiary institutions in Akwa Ibom State and found moderate awareness

but low utilization of the principles. Although the study further reported no significant gender differences in either awareness or utilization, the findings suggest that awareness of Green Chemistry does not necessarily translate into its effective application in practice. While previous studies have provided evidence on Green Chemistry awareness and application among secondary school students and Chemistry educators, limited evidence exists on Chemistry students in higher institutions in Akwa Ibom State, particularly with regard to the application of Green Chemistry principles to environmental waste management. Moreover, the extent to which such awareness and application may vary according to students' gender remains an area requiring further investigation.

Gender also plays a critical role in shaping environmental engagement, encompassing socially influenced roles, associations, traits, and behaviours (Umanah & Sunday, 2022; Umanah and Akpan, 2024). Although some previous studies report significant gender differences in environmental attitudes and behaviours, other studies find minimal differences or no significant difference. For example, Umanah, et. al., (2024) reported no significant differences among male and female students in awareness of green chemistry principles and environmental waste management. Similarly, Sunday & Edet (2024); Sunday, Umanah and Udofia (2025) reported no significant difference between male and female chemistry students. On the contrary, Jack and Shidawa, (2024) noted that females demonstrated higher attitude ratings toward green chemistry than their male counterparts. This underscores the importance of designing gender-sensitive curricula that empower all students to tackle environmental challenges effectively. It is against this comprehensive backdrop that the present study investigates chemistry students' awareness, attitudes, and practices of green chemistry principles in environmental waste management in higher institutions in Akwa Ibom State.

Statement of the Problem

In an era where environmental sustainability is paramount, the role of Chemistry in promoting eco-friendly practices is undeniable. However, within higher education institutions, a significant challenge persists: chemistry students often seem to exhibit limited awareness and understanding of Green Chemistry Principles in environmental waste management. This deficiency is further compounded by a lack of proactive attitude toward implementing sustainable practices. Despite the implications of human activities for the environment, there is consistent gas flaring, indiscriminate disposal of waste in entrance of cities, bush burning for agriculture, consistent tree felling and high use of fossil fuel in generators, car engines, pipeline vandalization is on daily increase. Without a clear understanding of a proactive awareness and application of green Chemistry Principles, future chemists may be ill-equipped to address the environmental hazards associated with conventional chemical processes and human activities.

Consequently, students seem not to effectively translate theoretical knowledge into practical applications to curb environmental degradation. The unhealthy negligence and lack of capacity to control and maintain the delicate balance of our environment underscores this research which sought to evaluate chemistry students' awareness and application of green chemistry principles in environmental waste management in higher institutions in Akwa Ibom State. As such, addressing this gap is crucial to equipping future chemists with the necessary knowledge and attitude to contribute meaningfully to environmental sustainability.

Purpose of the Study

The purpose of this study was to investigate Chemistry students' awareness and application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State. Specifically, this study sought to:

- i. Assess Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State.
- ii. Examine Chemistry students' level of application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State.
- iii. Determine the difference between male and female Chemistry students' level of awareness of green Chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State.
- iv. Examine the difference in male and female Chemistry students' level of application of green Chemistry principle in environmental waste management in higher institutions in Akwa Ibom State.

Research Questions

- What is the level of awareness of green chemistry principles application in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State?
- What is the level application of green Chemistry principles in environmental waste management among Chemistry students' in higher institutions in Akwa Ibom State?
- What is the difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State?
- What is the difference between male and female Chemistry students' level of application of green Chemistry principle in environmental waste management in higher institutions in Akwa Ibom State?

Hypotheses

- There is no significant difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State.
- There is no significant difference between male and female Chemistry students' level of application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State.

2. METHODS

This study adopted a descriptive survey research design to assess Chemistry students' awareness and application of Green Chemistry principles in environmental waste management without manipulating the variables. The population comprised 1,324 Chemistry and Chemistry Education students in the nine public tertiary institutions in Akwa Ibom State. A sample of 300 students was selected from four institutions using multistage sampling. Four institutions were selected through simple random sampling, after which 75 students were randomly selected from each institution. Data were collected using the Awareness of Green Chemistry Principles in Environmental Waste Management Questionnaire (AWGEQ) and Application of Green Chemistry Principles in Environmental Waste Management Questionnaire (AGEQ). Each instrument comprised 12 four-point Likert-scale items ranging from Very Highly Aware (VHA) = 4 points, Highly Aware (HA) = 3 points, Slightly Aware (SA) = 2 points, Not Aware (NA) = 1 point. The instruments were face-validated by three experts in Chemistry Education and Measurement and Evaluation. Trial testing with 30 Chemistry students outside the study sample yielded Cronbach's alpha coefficients of 0.85 and 0.82 for AWGEQ and AGEQ, respectively. The researcher, assisted by Chemistry educators, administered the instruments, of which 282 were correctly completed and retrieved, representing a 94% response rate. Mean and standard deviation were used to answer the research questions, while one-sample t-test and independent-samples t-test were used to test the hypotheses at the 0.05 level of significance. A cluster mean of 2.50 was used to determine the level of awareness and application, with mean scores of 2.50 and above indicating a high level and scores below 2.50 indicating a low level. For the t-tests, the null hypothesis was rejected when $p \leq .05$ and retained when $p > .05$.

3. RESULTS

Research Question One

What is the level of awareness of green chemistry principles application in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State?

Table 1: Mean and standard deviation of the level of awareness of green chemistry principles application (N=282)

S/N	Awareness of Green Chemistry Principles Application in Environmental Waste Management	Mean	SD	Decision
1.	I am aware of the principle of Prevention, which prioritizes waste prevention over remediation.	3.37	0.74	Agreed
2.	I understand the importance of the principle of Atom Economy in maximizing material incorporation into the final product.	3.10	0.98	Agreed

3.	I am knowledgeable about Less Hazardous Chemical Synthesis as a method to reduce the generation of toxic substances.	2.95	0.95	Agreed
4.	I recognize the importance of Designing Safer Chemicals to minimize inherent toxicity.	2.79	1.00	Agreed
5.	I understand the role of Safer Solvents/Auxiliaries in reducing hazardous substances during chemical processes.	3.15	0.89	Agreed
6.	I am aware of the principle of Design for Energy Efficiency in minimizing energy consumption in chemical reactions	2.78	0.97	Agreed
7.	I comprehend the significance of using Renewable Feedstocks as sustainable alternatives to fossil-based resources.	2.89	0.93	Agreed
8.	I know about the principle of Reduce Derivatives which promotes minimizing unnecessary steps in chemical synthesis.	2.83	0.93	Agreed
9.	I am aware that Catalysis is essential in reducing waste.	2.91	0.95	Agreed
10.	I understand the importance of Design for Degradation, ensuring that chemical products decompose into non-harmful substances after use.	2.82	0.90	Agreed
11.	I am knowledgeable about Real-Time Analysis for Pollution Prevention, which involves monitoring reactions to reduce environmental impact.	2.86	1.03	Agreed
12.	I recognize the principle of Inherently Safer Chemistry for Accident Prevention, which emphasizes risk minimization at the design stage.	3.01	0.90	Agreed
Cluster Mean		2.96	0.93	HL

Table 1 shows that all 12 items had mean scores above the criterion mean of 2.50, ranging from 2.78 to 3.37, indicating agreement with all the awareness statements. The highest mean was recorded for awareness of the Prevention principle ($M = 3.37$, $SD = 0.74$), while Design for Energy Efficiency had the lowest mean ($M = 2.78$, $SD = 0.97$). The cluster mean of 2.96 ($SD = 0.93$) indicates there is high level of awareness of Green Chemistry principles application in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State.

Research Question Two: What is the level of application of green Chemistry principles in environmental waste management among Chemistry students' in higher institutions in Akwa Ibom State?

Table 2: Mean and standard deviation of the level of application of green Chemistry principles (N=282)

S/N	Application of Green Chemistry Principles in Environmental Waste Management	Mean	SD	Decision
1.	I applied the principle of Prevention, which prioritizes waste prevention over remediation.	3.40	0.87	Agreed
2.	I applied the principle of Atom Economy in maximizing material incorporation into the final product.	3.01	0.99	Agreed
3.	I applied the principle of Less Hazardous Chemical Synthesis as a method to reduce the generation of toxic substances into the environment.	2.75	1.11	Agreed
4.	I encourage the importance of Designing Safer Chemicals to minimize inherent toxicity.	2.93	0.98	Agreed
5.	I use the role of Safer Solvents/Auxiliaries in reducing hazardous substances during chemical processes.	2.93	0.91	Agreed
6.	I promote the use of Design for Energy Efficiency in minimizing energy consumption in chemical reactions	2.99	1.17	Agreed
7.	I use Renewable Feedstocks as sustainable alternatives to fossil-based resources.	2.61	1.02	Agreed
8.	I applied the principle of Reduce Derivatives which promotes minimizing unnecessary steps in chemical synthesis.	2.84	0.91	Agreed

9.	I use Catalysis in reducing waste.	2.86	0.99	Agreed
10.	I applied Design for Degradation to ensure that chemical products decompose into non-harmful substances after use.	2.88	0.99	Agreed
11.	I use Real-Time Analysis for Pollution Prevention, which involves monitoring reactions to reduce environmental impact.	2.96	1.07	Agreed
12.	I applied the principle of Inherently Safer Chemistry for Accident Prevention, which emphasizes risk minimization at the design stage.	2.95	1.02	Agreed
13.	I practice the current recycling processes such as incineration, source reduction in environmental waste management.	3.00	0.98	Agreed
14.	I practice "reduce, reuse, recycle" approach in environmental waste management	2.95	1.14	Agreed
Cluster Mean		2.93	1.01	HL

Table 2 shows that all 14 items had mean scores above the criterion mean of 2.50, ranging from 2.61 to 3.40, indicating agreement with all the practice statements. The highest mean was recorded for the Prevention principle ($M = 3.40$, $SD = 0.87$), while Renewable Feedstocks had the lowest mean ($M = 2.61$, $SD = 1.02$). The cluster mean of 2.93 ($SD = 1.01$) indicates there is high level of application of Green Chemistry principles in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State.

Research Question Three: What is the difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State?

Table 3: Mean and standard deviation of the difference between male and female Chemistry students' level of awareness of green chemistry principles application (N= 282)

Gender	N	Mean	SD	Mean Difference
Female	140	2.98	0.46	0.05
Male	142	2.93	0.35	

The result in Table 3 shows that the mean score of 2.98 obtained by female students was almost the same with that of 2.93 obtained by their male counterparts with a small mean difference of 0.05. The standard deviation scores of 0.46 and 0.35 obtained by female and male students respectively; showed that the scattering of the raw scores from the mean was a bit wider among the female students. This means that there is no substantial difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State.

Research Question Four: What is the difference between male and female Chemistry students' level of application of green Chemistry principle in environmental waste management in higher institutions in Akwa Ibom State?

Table 4: Mean and standard deviation of the difference between male and female Chemistry students' level of application of green Chemistry principle (N=282)

Gender	N	Mean	SD	Mean Difference
Female	140	2.94	0.49	0.01
Male	142	2.93	0.44	

The result in Table 4 shows that the mean score of 2.94 obtained by female students was almost the same with that of 2.93 obtained by their male counterparts with a small mean difference of 0.01. The standard deviation scores of 0.49 and 0.44 obtained by female and male students respectively; showed that the scattering of the raw scores from the mean was a bit wider among the female students. This means that there is no substantial difference between male and female Chemistry students' level of application of green Chemistry principle in environmental waste management in higher institutions in Akwa Ibom State.

Hypothesis One: There is no significant difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State

Table 5: Independent t-test analysis of the difference between male and female Chemistry students' level of awareness of green chemistry principles application (N =282)

Gender	N	Mean	SD	t-value	Sig.	Decision
Female	140	2.98	0.46	0.97	0.33	Not significant
Male	142	2.93	0.35			

Not significant at $P > .05$; $df = 280$

The result in Table 5 shows the t-value of 0.97 and the corresponding probability level of significance of .33 alpha at 280 degrees of freedom. This level of significance is greater than .05 in which the decision is based. With this result, the null hypothesis was retained. This implies that there is no significant difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State.

Hypothesis Two: There is no significant difference between male and female Chemistry students' level of application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State

Table 6: Independent t-test analysis of the difference between male and female Chemistry students' level of application of green Chemistry principles (N =282)

Gender	N	Mean	SD	t-value	Sig.	Decision
Female	140	2.94	0.49	0.11	0.91	Not significant
Male	142	2.93	0.44			

Not significant at $P > .05$; $df = 280$

The result in Table 6 shows the t-value of 0.11 and the corresponding probability level of significance of .91 alpha at 280 degrees of freedom. This level of significance is greater than .05 in which the decision is based. With this result, the null hypothesis was retained. This implies that there is no significant difference between male and female Chemistry students' level of application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State.

4. DISCUSSION OF FINDINGS

The finding on level of awareness of Green Chemistry principles application in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State revealed that there is high level of awareness of Green Chemistry principles application in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State. The finding may be attributed to the nature of Chemistry as a discipline and the structure of its curriculum. Chemistry programmes at the tertiary level expose students to concepts related to environmental protection, chemical safety, waste disposal, sustainability, and pollution control through courses such as environmental chemistry, industrial chemistry, and laboratory safety. In addition, growing public discourse on environmental sustainability, climate change, and waste management in Nigeria may have enhanced students' general environmental consciousness, which translates into higher awareness of green chemistry principles. The finding aligns with that of Awoyode, (2024) whose finding showed that secondary school students' are aware of the green chemistry principles. The finding also aligns with that of Hussain (2024) whose finding revealed high levels of green Chemistry knowledge and attitudes, and very high levels of awareness.

The finding on the level of application of Green Chemistry principles in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State revealed that there is high level of application of Green Chemistry principles in environmental waste management among Chemistry students in higher institutions in Akwa Ibom State. The result may be explained by the practical orientation of Chemistry education. Students are often required to adhere

strictly to laboratory rules, including proper waste segregation, safe disposal of chemical residues, minimisation of hazardous substances, and adherence to environmental guidelines. These practices are not only encouraged but enforced through laboratory supervision, continuous assessment, and safety protocols. Consequently, students may internalise these behaviours and consistently practice them during laboratory activities, leading to a high level of reported applications. The finding contradicted that of Alake, (2013) and Atabang (2024) who found that the students at the secondary school level do not transfer what is learned in the classroom to life experience and situations. The finding contradicted that of Amoah (2022) whose finding showed that while the majority of students had heard of green chemistry, they had limited knowledge and understanding of the concepts.

The finding of the difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State revealed that there is no significant difference between male and female Chemistry students' level of awareness of green chemistry principles application in environmental waste management in higher institutions in Akwa Ibom State. This finding implies that both genders are exposed to similar academic content and learning experiences. In higher institutions, Chemistry students, regardless of gender, follow the same curriculum, attend the same lectures, use the same laboratories, and are subjected to the same safety instructions. This uniform exposure may likely result in comparable levels of awareness among male and female students. The finding is in line with that of Saadon, and Abbood, (2022) who found that there is no effect of the gender variable (male-female) on awareness of green chemistry concepts. The finding is also in line with that of Umanah, Arop, and Neji, (2024) whose results showed that there was no significant difference in the level of male and female chemistry educators' awareness and utilization of green chemistry principles in tertiary institutions in Akwa Ibom State.

The finding of the difference between male and female Chemistry students' level of application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State revealed that there is no significant difference between male and female Chemistry students' level of application of green Chemistry principles in environmental waste management in higher institutions in Akwa Ibom State. The finding may be explained by the standardized nature of laboratory activities and regulations. In science laboratories, all students are required to follow the same procedures, safety rules, and waste management practices, irrespective of gender (Atabang & Umanah 2024). Compliance is monitored uniformly, and deviations are often penalised, ensuring consistency in practice across all students. As a result, both male and female students demonstrate similar levels of engagement in green chemistry in environmental waste management. The finding contradicts the observation of McCright and Xiao (2014) who reported that women, on average, express greater concern for environmental issues than men, a trend attributed to socialization processes that emphasize caregiving and communal values. The finding contradicts with the observation of Umanah and Sunday, (2022) and Umanah and Atabang (2025) who reported that gender also plays a critical role in shaping environmental engagement, encompassing socially influenced roles, associations, traits, and behaviours.

5. CONCLUSION

Based on the findings of the study, it was concluded that Chemistry students in higher institutions in Akwa Ibom State possess a high level of awareness and a high level of application of green chemistry principles in environmental waste management. Gender does not significantly influence students' awareness, or application in this regard.

6. RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1. Given the high level of awareness, and high level of application of green Chemistry principles in environmental waste management among students, Chemistry lecturers should sustain and further strengthen the integration of green chemistry concepts into teaching and laboratory activities
2. Higher institution management should support and institutionalize green Chemistry application by providing adequate laboratory facilities, environmentally friendly reagents, and proper waste management infrastructure.
3. Environmental agencies should collaborate with higher institutions to support training, workshops, and sensitization programmes on green chemistry Principles in environmental waste management for both male and female students.
4. Chemistry lecturers should continue to adopt inclusive teaching and laboratory supervision strategies that engage both male and female students equally.

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