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TOWARDS ENVIRONMENTAL SUSTAINABILITY: ASSESSMENT OF CHEMISTRY TEACHERS' ATTITUDE TOWARDS GREEN CHEMISTRY

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ABSTRACT

The study investigated chemistry teachers' attitude towards green chemistry in Jalingo, Taraba state, Nigeria. Four research questions and three hypotheses guided the study. A descriptive survey research design was adopted for the study. The population comprised all the chemistry teachers in both public and private secondary schools in Jalingo from which 70 chemistry teachers were sampled and used for the study through convenience sampling. The instrument, Teachers' attitude towards green chemistry scale (TAGCS) was used for data collection. Its validity was ensured by three (3) experts while its reliability index was found using cronbach alpha reliability co-efficient to be 0.81. It was found that chemistry teachers' attitude towards green chemistry in Jalingo, Taraba State is positive (grand mean= 3.17). The results revealed that chemistry teachers have positive attitude towards green chemistry. It also revealed that the female chemistry teachers, teachers with Master's degree qualification and above, and teachers with five years of chemistry teaching experience and above all had higher mean attitude rating towards green chemistry than their respective counterparts. However, each of these differences was found not to be statistically significant (p>0.05). It was concluded that the positive attitude shown by chemistry teachers towards green chemistry signifies that they are working towards and ready for environmental sustainability. Therefore, it was recommended among others that periodic seminars about green chemistry be organized for chemistry teachers in order to sustain this good attitude.

Keywords: Environmental Sustainability, Chemistry Teachers, Attitude, Green Chemistry.

Introduction

Education plays an important role in increasing every individual's awareness in maintaining the environment preservation by integrating environmental sustainability. The United Nations' States are working towards achieving the 2030 sustainable development goals spelled out in 2015. With few years left (about 6 years), it is crucial to assess the affairs of some of the key components that have been tailored towards achieving the goals of making developments sustainable. Sustainable development has been widely regarded by the United Nations (UN) to be a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (as cited in Monday, 2021). The environment is one of the greatest assets of humans; consequently, its sustainability deserves priority. Anthropogenic activities have resulted into the depletion of ozone layer, thereby causing global warming. Similarly, floods, outbreak of diseases, pollution, among others have affected the overall quality of the environment. This has consequently made our environment to be unsustainable. There is already a growing campaign worldwide relevant to the need to achieve environmental sustainability and development (Estalilla, 2022).

Environmental conservation, pollution, green chemistry among others have been utilized to champion environmental sustainability with green chemistry being the relatively the most novel terms. Husseini and Ahmed (2021) viewed Green Chemistry to be concerned with the use of alternative resources and environmentally safe technology, aimed at preventing pollution from the beginning rather than addressing it after its formation. Green chemistry as defined by United States Environmental Protection Agency (EPA) Green chemistry (EPA, 2020) is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, use, and ultimate disposal.

Green chemistry according to EPA, (2020) is also known as sustainable chemistry and is anchored on twelve (12) principles which demonstrate the breadth of the concept which includes: pollution prevention, atom economy, less hazardous chemical synthesis; design of safer chemicals; the use of safer solvents and auxiliaries, design for energy efficiency; use of renewable feedstock; reduction of derivatives; catalysis; design for degradation, real-time analysis for pollution prevention; and inherently safer chemistry for accident prevention. For instance, practical activities that could cause the release of harmful radiation to the surrounding could be simulated instead of physically being conducted; plastic containers that are non-biodegradable could be replaced by the production of more biodegradable plastics, power generation through combustion of fuel should be discouraged and solar energy which is more environmentally friendly should be utilized among others.

Green chemistry has emerged as a potent tool of driving environmental sustainability. This is because, Ware asserted that chemistry itself has the potential to solve problems faced by societies as they struggle to achieve sustainable development, due to the fact that people frequently interact with chemistry and industries (as cited in Owoyemi & Moju, 2020). For example, plastic wastes, products of chemical industries, degrade our environment making it unsustainable. Furthermore , it has been revealed by Monday (2021) that ten (10) out of the seventeen (17) sustainable development goals agreed on by the United Nation in 2015 were linked to chemistry by the Global Chemicals Outlook II. Furthermore, Ogunyemi et al. (2022) asserted that education is the key driver of the UN's 17 sustainable development goals (SDGs). This makes the roles of teachers pertinent as the society yearns for sustainable development.

At the 2015 World Education Forum in Korea, the need for pro-sustainability educators was recognized as critical to actualizing the 2030 Global Agenda for Sustainable Development (Ogunyemi et al., 2022). This implies that teachers have a crucial role in educating students as good citizens who are knowledgeable about environmental issues, environmentally-conscious and responsible (Kumar, 2017). According to Jack and Tella (2021) teachers play an important role in generating environmental sustainability through Green chemistry approach that involves critical thinking needed to help the students to solve everyday problem in their immediate environment. This particularly concerns chemistry teachers because chemistry is one of the science subjects that prioritize environmental

consciousness. Teachers of chemistry are expected to apply and transmit the knowledge of this to their students (Oyelekan & Salihu, 2022). For Monday (2021), the care and sustainability of this environment hinges on the decisions, behaviour and attitude of the citizens. Consequently, attitude of teachers towards green chemistry is crucial for the realization of environmental sustainability.

Apparently, if there is an attitudinal problem, a teacher who is knowledgeable of green chemistry will neither practice nor teach it unless that attitudinal problem is addressed. It is commonly believed that teachers' positive attitude is a function of their job satisfaction (Odike & Nnaekwe, 2018). Turner opined that teachers need to imbibe positive attitudes towards and show concern for environmental issues before they will be able to train and produce students who are environmentally literate (as cited in Owoyemi & Adesina, 2020). The attitude of teachers towards green chemistry could determine how ready they are to embrace, practice and integrate green chemistry principles into the teaching and learning process. Expression of desire to know more, being ready to incorporate it into their activities inside and outside the classroom, and taking responsibility are some of the ways chemistry teachers can show a positive attitude towards green chemistry.

A number of studies have been conducted concerning teachers attitude towards concepts that point towards environmental sustainability. Fatoba and Aladejana (2014) reported positive teachers' attitude to natural resources conservation. Kumar (2017) on the other hand found no meaningful difference in the attitude of male and female teachers towards environmental education even though male had a slightly better attitude. It was also previously found in Owoyemi and Moju (2020) that teachers have positive attitudes towards incorporating green chemistry to classroom practices with no significant difference between male and female teachers' attitude. Olufemi et al. (2014) found that a significant difference exists between the attitude of male and female teachers concerning environmental pollution in favour of male teachers. However it was also found therein that no significant difference exist in attitude towards environmental pollution by teachers' qualifications and experience. Elina (2016) found that more qualified teachers seem to have more positive attitudes than the less qualified teachers.

Apparently, a positive attitude of teachers about environmental sustainability concepts like green chemistry alludes that they incorporate and model it for the students thereby contributing towards the attainment of the sustainable development goals and vice versa. It is light of the foregoing that this study assessed chemistry teachers' attitude towards green chemistry in Jalingo metropolis. Specifically, the study:

1) Determined the attitude of chemistry teachers towards green chemistry

2) Ascertained the attitude of chemistry teachers towards green chemistry based on gender

3) Determined the attitude of chemistry teachers towards green chemistry based on academic qualification

4) Compared the attitude of chemistry teachers towards green chemistry based on their years of chemistry teaching experience.

The objectives engendered four research questions as follows:

1) What is the attitude of chemistry teachers towards green chemistry?

2) What is the attitude rating score of chemistry teachers towards green chemistry based on gender?

3) What is the attitude rating score of chemistry teachers towards green chemistry based on academic qualification?

4) What is the attitude rating score of chemistry teachers towards green chemistry based on their years of chemistry teaching experience?

Furthermore, three (3) null hypotheses guided the study:

$H0_1$: There is no significant difference in the mean attitude rating score of chemistry teachers towards green chemistry based on gender.

$H0_2$: There is no significant difference in the attitude rating score of chemistry teachers towards green chemistry based on academic qualifications

$H0_3$: There is no significant difference in the attitude rating score of chemistry teachers towards green chemistry based on their years of chemistry teaching experience

Research Method

A descriptive survey research design was adopted for the study. The population comprised all the chemistry teachers in both public and private secondary schools in Jalingo, Taraba State. From the population, 70 chemistry teachers were selected through simple random sampling. The instrument for data collection was titled; Teachers attitude towards green chemistry scale (TAGCS) and its items were adopted from Owoyemi and Moju (2020). It contained two sections: section A determined the socio-demographic information of the respondents; section B contained 8 items which determined the attitude of chemistry teachers towards green chemistry. The items were stated in the positives and were structured on a 4-point scale of Strongly Agree (SA), Agree (3), Disagree (D), and Strongly Disagree (SD). The face and content validity of the instrument was ensured by three experts from the department of Science Education, Taraba State University Jalingo.

A pilot test was conducted with 30 chemistry teachers outside the population which did not take part in the main study. The data from the pilot test was used to ascertain the reliability of the instrument and a coefficient of 0.80 was obtained using cronbach alpha reliability method. The instrument was deemed reliable. Mean and standard deviation were used to answer the research questions with the benchmark pegged at 2.50. A mean above showed respondents have a good positive attitude towards green chemistry while a mean below 2.50 indicated poor attitude. This was used to answer research question 1. The 8 items on attitude meant the cumulative maximum and minimum total scores obtainable by respondents are 32 and 8 respectively. The cumulative rating of all the items of a respondent represented their attitude scores. This was used to answer research question 2, 3 and 4. Null hypotheses 1 was tested using t-test since it involved mean of two groups only while null hypotheses 2 and 3 were tested using the analysis of variance (ANOVA) since they involved three groups all at 0.05 level of significance. All statistical analyses were done on the Statistical Package for Social Sciences (SPSS).

Presentation of Results

Research Question 1: What is the attitude of chemistry teachers towards green chemistry?

Table 1: Mean and standard deviation of teachers' response to items on their attitude towards green chemistry

S/No	Items	N	Mean	Std dev.
1	I would like to know more about green chemistry	70	3.30	0.57
2	I am ready to incorporate green chemistry principles in my laboratory practices	70	3.10	0.75
3	I have a responsibility to engage in green practices	70	3.11	0.55
4	As a teacher I have a pivotal role to incorporate green chemistry in the curriculum	70	3.07	0.71
5	Green Chemistry concepts in the curriculum can help to correct the current environmental issues	70	3.03	0.78
6	I need to be trained so as to be able to incorporate green chemistry in the curriculum	70	3.36	0.57
7	As a teacher I can play an important role in solving environmental problems through green chemistry	70	3.16	0.67
8	As a teacher I believe that the knowledge of Green Chemistry is necessary for chemistry students	70	3.23	0.54
	Grand Total		3.17	0.65

Table 1 shows that most of the teachers have positive attitude towards green chemistry concepts evident in the fact that each of the items had a mean greater than 2.5 and overall, the grand mean of 3.17 with standard deviation of 0.65 shows that chemistry teachers in Jalingo, Taraba state have positive attitude towards green chemistry.

Research Question 2: What is the attitude rating score of chemistry teachers towards green chemistry based on gender?

Table 2: Mean and standard deviation of teachers' attitude towards Green Chemistry by gender

Gender	N	Mean	Std dev
Male	49	25.02	2.76
Female	21	26.14	2.29

The mean score of teachers' attitude towards green chemistry has been captured in Table 2 and it shows that female chemistry teachers have a slightly higher mean attitude rating score and lower standard deviation (Mean= 26.14, SD = 2.29) than the male chemistry teachers (Mean = 25.02, SD = 2.76). The mean difference is therefore 1.12 in favour of the female teachers.

Research Question 3: What is the attitude rating score of chemistry teachers towards green chemistry based on academic qualification?

Table 3: Mean and standard deviation of teachers' attitude towards Green Chemistry by their academic qualifications

Qualification	N	Mean	Std dev
NCE	21	25.57	2.86
B.deg	41	24.95	2.22
M.deg & above	8	26.88	3.80

The mean attitude rating scores of chemistry teachers based on their academic qualifications have been captured in Table 3. Teachers with Master's degree qualification and above had the highest mean and standard deviation as well (means= 26.88, SD = 3.80). This mean is 1.93 higher than teachers with bachelor's degree qualification (mean = 24.95, SD= 2.22), and 1.31 higher than teachers with NCE qualification (mean= 25.57, SD=2.86).

Research Question 4: What is the attitude rating score of chemistry teachers towards green chemistry based on their years of chemistry teaching experience?

Table 4: Mean and standard deviation of teachers' attitude towards Green Chemistry by years of chemistry teaching experience

Years of Experience	N	Mean	Std dev
1-2	22	25.14	2.61
3-4	27	25.19	2.09
5-above	21	25.81	3.36

Table 4 shows the mean attitude rating scores of chemistry teachers based on their years of chemistry teaching experience. From the table, it could be deduced that the higher the years of experience, the higher the mean attitude score. Teachers with 1 to 2 years of experience had a mean of 25.14 and SD of 2.61; teachers with 3 to 4 years of experience had a mean of 25.19 and SD of 2.09; while teachers with more than 5 years of teaching experience had the highest mean of 25.81 with SD as 3.36.

Ho_1: There is no significant difference in the mean attitude rating score of chemistry teachers towards green chemistry based on gender.

Table 5: t-test result of teachers' attitude towards Green Chemistry by gender

Gender	N	Mean	Std dev	T	Df	Sig.
Female	21	26.14	2.29	1.638	68	0.106
Male	49	25.02	2.76			

Table 5 shows the data of independent t-test analysis shows that the there is no significant difference in the mean attitude towards green chemistry rating score of female and male chemistry teachers as p= 0.106. The p-value is greater than the benchmark 0.05.

Ho_2: There is no significant difference in the attitude rating score of chemistry teachers towards green chemistry based on academic qualifications

Table 6: ANOVA result of teachers' attitude towards Green Chemistry based on academic qualification

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	26.151	2	13.076	1.897	0.158
Within Groups	461.920	67	6.894		
Total	488.071	69			

The ANOVA result in Table 6 shows that there is no significant difference in the mean attitude towards green chemistry rating of chemistry teachers based on their academic qualifications (F=1.897, p=0.158>0.05)

Ho_3: There is no significant difference in the attitude rating score of chemistry teachers towards green chemistry based on their years of chemistry teaching experience.

Table 7: ANOVA result of teachers' attitude towards Green Chemistry based on years of chemistry teaching experience

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.168	2	3.084	0.429	0.653
Within Groups	481.903	67	7.193		
Total	488.071	69			

The ANOVA result in Table 7 shows that there is no significant difference in the mean attitude towards green chemistry rating of chemistry teachers based on their years of teaching experience (F= 0.429 p=0.653 >0.05)

Discussion of Findings

The findings of the study revealed that chemistry teachers have positive attitude towards green chemistry concepts. They demonstrated their willingness to learn about it and incorporate it into their classroom practices. This is consistent with the report by Owoyemi and Moju (2020) who found chemistry teachers' positive attitude to integration of green chemistry. It is also similar to Fatoba and Aladejana (2014) who found positive teachers attitude to natural resources conservation; all of which points towards environmental sustainability.

Similarly, it was found that female chemistry teachers had a higher mean attitude towards green chemistry than the male teachers. This is similar to the finding of Keles (2017) who found that attitude towards sustainable environmental education among female pre-service teachers is higher than their male counterparts even though, in addition, the difference was not statistically significant. However, this contradicts Kumar (2017) who found male teachers to have more positive attitude towards environmental education than their female counterparts. The difference in the chemistry teachers' attitude by gender was found not to be statistically significant; consequently corroborating Kumar (2017), and Owoyemi and Moju (2020) who found no significant difference between female and male teachers attitude towards green chemistry.

Chemistry teachers' attitude towards green chemistry based on their academic qualifications was found and the teachers with the highest qualification showed the highest attitude. This is consistent with Soibamcha and Pandey (2016) who found out that more qualified teachers show more positive attitudes than the less qualified teachers. Furthermore, the difference was not statistically significant which corroborates Olufemi et al. (2014). The findings on attitude towards green chemistry among teachers were also segregated based on the years of chemistry teaching experience. Teachers with more years of experience had higher attitude rating than their younger colleagues. However, the difference was not significant - a finding consistent with Olufemi et al. (2014) who found that years of teaching experience have no effect on

teachers' attitude towards environmental pollution.

Conclusion and Recommendations

Apparently, chemistry teachers have environmental sustainability at heart since they have demonstrated positive attitudes towards green chemistry. Postgraduate institutions have played an important role to this regards, so also has teachers years of experience because the years of experience are accompanied by plethora of career development opportunities. It can be concluded forthwith that chemistry teachers are contributing their quota and working assiduously towards environmental sustainability. Subsequently, the findings have engendered the following recommendations:

1. The Ministry of Education should organize seminars periodically for chemistry teachers on green chemistry. So doing will sustain the positive attitude demonstrated by the chemistry teachers towards green chemistry.
2. The school administrators should provide equal opportunities for male and female teachers' development, access to educational materials among others in order to foster and sustain their attitude towards green chemistry.
3. Since teachers' qualification is closely tied to their attitude towards green chemistry, school administrators should provide opportunities for professional development of chemistry teachers and financial aids as well to augment their educational qualifications.
4. Experienced chemistry teachers should guide the younger generations of chemistry teachers as the both strive to sustain their attitude towards green chemistry.

REFERENCES

EPA, (2020). *Basics of Green Chemistry*. United States Environmental Protection Agency, United States Government. epa.gov/greenchemistry/basics-green-chemistry#twelve.

Estalilla, K. C. S. (2022). Extent of knowledge towards green chemistry of science teachers. *International journal of advanced multidisciplinary studies*, 2(1), 99-130.

Fatoba, J. O. & Aladejana, A. L. (2014). The attitudes of biology teachers and students toward the conservation of natural resources in Ekiti state, Nigeria. *European journal of educational sciences*, 1(4), 38-46.

Jack, G. U. & Tella, C. D. (2021). Chemistry teachers' awareness and utilization of green chemistry as innovative approach in teaching chemistry in Senior Secondary School in Jalingo education zone, Taraba State. *Journal of Science, Technology, Mathematics and Entrepreneurial Education (JSTMEE)*, 1(3), 170-177.

Husseini, A. A. & Ahmed, S. (2021). Awareness of the principles of green chemistry among middle school teachers. *Turkish journal of computer and mathematics education*, 12(7), 475-483.

Keles, O. (2017). Investigation of pre-service science teachers' attitudes towards sustainable environmental education. *Higher Education Studies*, 7 (3), 171-180.

Kumar, H. (2017). A study of attitude of teachers towards environmental education at secondary level. *International Journal of Research in Engineering, IT and Social Sciences*, 7(10), 81-84.

Monday, M. (2021). Pre-service chemistry teachers' knowledge of green chemistry principles and attitude as determinant of their behaviour towards environmental sustainability. *Nigerian Online Journal of Educational Sciences and Technology (NOJEST)*, 3(2), 45-53.

Odike, M. & Nnaekwe, U. K. (2018). Influence of teachers' attitude towards teaching profession on under graduate non-education students' perception of teacher education. *International Journal of Academic Research in Progressive Education and Development*, 7(4), 67-79.

Ogunyemi, B., Ifegbesan, A., Benedict, H. T., Ogunsanya, A. O., Iyunade, O. T., Olubela, A., Itasanmi, B., Edewor, K. (2022). Knowledge, perceptions and readiness of Nigeria's beginning teachers for sustainability education. *Journal of teacher education for sustainability*, 24(2), 180-194.

Olufemi, C., Adejoke, O. C., Mji, A. & Mukhola, M. S. (2014). Students' and teachers' awareness of and attitude towards environmental pollution: a multivariate analysis using biographical variables. *Journal of human ecology*, 45 (2), 167-175.

Owoyemi, T. E. & Adesina, A. S. (2020). Pre-service and in-service chemistry teachers' knowledge and attitude to green chemistry in Lagos state, Nigeria. *Journal of Curriculum and Instruction*, 13 (1), 22-33.

Owoyemi, T. E. & Moju, M. (2020). Investigating chemistry teachers' perception and attitude towards integration of green chemistry principles into secondary school chemistry curriculum: a case study of Lagos state. *Journal of curriculum and instruction*, 13(1), 22-33.

Owoyemi, T. E. & Umanah, F. I. (2019). Chemistry teachers' knowledge of the concept and principles of green chemistry based on professional qualification in Akwa Ibom State. *Journal of the Science Teachers Association of Nigeria*, 54(1), 149-157.

Oyelekan, O. S. & Salihu, H. A. (2022). Teachers' knowledge of green chemistry in senior secondary schools in Kwara state, Nigeria. *VNU Journal of science: education research,* 38(4), 54-68.

Soibamcha, E. & Pandey, N. (2016). Attitude of teachers towards teaching profession. *Global Journal of Interdisciplinary Social Sciences*, 5(3), 49-51.