The Role of Gender on Chemistry Teachers' Knowledge of Green Chemistry in Lagos State, Nigeria

Owoyemi, Toyin Eunice
Dept. of Science & Technology Education
Faculty of Education, University of Lagos
Email: towoyemi@unilag.edu.ng

And

Adesina, Adeleke Sunday
Dept. of Science & Technology Education
Faculty of Education, University of Lagos
Email: aadesina@unilag.edu.ng

Abstract

The world all over, Nigeria inclusive, is faced with a lot of environmental problems as a result of unlawful refuse disposal, technological innovations, oil spillage, release of greenhouse gases, pollution and many more. This calls for immediate and pragmatic approaches in Chemistry Education most especially, Green Chemistry, which emphasizes the need to design chemical processes and products by using eco-friendly and non-toxic feed stock while reducing or eliminating the generation of hazardous substances. Therefore, there is the need for adequate knowledge of Green Chemistry for every Chemistry teacher. This study therefore, investigated the role of gender on Chemistry teachers' knowledge of Green Chemistry in Lagos State, Nigeria. Descriptive survey research design was adopted in this study. Multi-stage sampling technique was used for the selection of schools while 160 (93 males and 67females) teachers participated in the study using convenient sampling technique. A research instrument titled "Teachers' Knowledge of Green Chemistry Questionnaire" (TKGCQ) was used to elicit information about the perceived and measured knowledge of Chemistry teachers. The instrument which was made up of three Sections (A, B, &C) was validated by experts in items development in Chemistry Education. The reliability of the perceived knowledge (Section B) was established using Cronbach's alpha which gave a reliability index of 0.71; while that of the measured knowledge (Section C) was determined using Split-half method with a reliability index of 0.68. Two hypotheses were formulated and tested using independent sample t-test statistic at 0.05 level of significance. The findings showed that both male and female teachers had low and similar perceived knowledge of Green Chemistry. But gender influenced their actual content knowledge; the male teachers had more knowledge of Green Chemistry than their female counterparts. It was therefore, recommended, among others, that, policy makers should embrace the need to integrate Green Chemistry principles into teacher education curriculum, while relevant capacity building workshops/seminars and in-service training programmes should be made available for Chemistry teachers at all levels, with more opportunities for female teachers to acquire adequate knowledge in Green Chemistry.

Introduction

Our world today is faced with environmental degradation resulting from menacing human and industrial activities in the quest for survival, civilization and technological advancement. Anthropogenic changes, unlawful refuse disposal, technological innovations, oil spillage, release of greenhouse gases, pollution and inappropriate disposal of toxic substances by industries resulting to inimical climatic changes have affected the course of our natural existence and biodiversity. The warming of the earth due to the depletion of the ozone layer, flood and ocean rise, outbreak of endemic diseases, and frequent inhaling of polluted air have all resulted in a high mortality rate of human lives and made our environment unsustainable. Our world is becoming mor uncomfortable to live in even as the population increases exponentially on a daily basis.

This calls for immediate and pragmatic approaches in Science Education, especially in Chemistry, that will mitigate the negative impact of these hostile environmental practices and also provide a sustainable and economical solutions. The role of Chemistry in environmental sustainability cannot be over-emphasized as most pollutants are produced from chemical processes and practices and therefore, can be tackled through environmentally induced research in sustainable Chemistry otherwise called Green Chemistry. Green Chemistry (GC) is an area of Chemistry that emphasizes the need to design chemical processes and products by using eco-friendly and non-toxic feedstock while reducing or eliminating the generation of hazardous substances. It focuses on how pollution can be prevented right from the source rather than cleaning it up after its generation through chemical processes (Anastas. 2009). Therefore, adequate knowledge of GC is a must for every Chemistry teacher in this era of rapid climate change and global warming if we are really interested in environmental sustainability, that is, making our environment habitable to this present generation and future.

Few studies revealed that Chemistry teachers had some level of knowledge of the concept of Green Chemistry compared to the pre-service Chemistry teachers in Nigeria. Also, the positive attitude towards the teaching of Green Chemistry was reported among Chemistry teachers (Owoyemi & Adesina, 2020). But there is the need to investigate the influence of some variables such as gender, on their knowledge, hence, the present study was considered very important.

Policies on gender from the Environmental Union make a clear distinction between gender and sex. Sex refers to biological features like physiology, genes and physical anatomy which differentiate males from females. Gender refers to a set of socially influenced roles and associations, human traits, attitudes and behaviours that differentiate both sexes. Gender is relative in nature as gender roles and features are defined in relation to one another. Klinge and Bosch (2001) defined gender as a system of signs and symbols representing the relationships of power and hierarchy between the sexes and related to both women and men.

Toxic chemicals and wastes destroy human health, irrespective of gender. The daily activities of men and women affect their exposure to these toxic chemicals. Men work more in industries that are involved in the production of chemicals and products which put them more at risk of higher exposure to toxic chemicals than women who work mostly domestically and in a not much more industrialized environment, thus reducing their risk exposure. Physiological differences can make the exposure of women to toxic chemicals more precarious with increased chances of having diseases such as cancer, foetal dysfunctions, toxin transfer through breast feeding and mental

disabilities in their children. These, cumulatively, has a long lasting impact on society as a whole.

Existing literature which supported the roles of gender in environmental sustainability posited that there was a significant difference in how males and females related with each other and the environment. Females tend to relate more with the environment on an emotional level than males (Bloodhart& Swim, 2010; Stephens, Jacobson, & King, 2010). Societal factors also play a prominent role in determining eco-friendly behaviour (Nolan et al et al 2008). It asserts that the involvement of women in social and family roles has created an innate ability in them to experience both cultural and environmental roles (Sandilands, 1998).

Environmental feminist protagonists perceive that there is an important biological and sociological relationship between women and nature. They posit that women are more intimate with nature because of their roles as mothers, home-keepers and caretakers while men focus more on mastering nature (Bloodhart et al., 2010). However, previous research on environmental knowledge and gender revealed that men possessed a higher environmental knowledge relative to women. Arcury (1990) posits that an individual's gender was a determining factor that differentiated the level of environmental knowledge a person possessed. According to Gendall and Smith (1995), men tend to have a higher level of knowledge than women. Tikka et al (2000) also asserted that gender differences influenced environmental knowledge as the men possessed averagely higher knowledge that women. That was further established by Briggs et al (2003) who posited that women's environmental knowledge was inadequate when compared to that of men. Similarly, the report by Mostafa (2007) revealed that the difference in the environmental knowledge of men and women was significant, the perceived knowledge of men was higher than that of women.

In developed countries, Green Chemistry principles have gained global acceptability, but its knowledge and practice are yet to be pronounced in Nigeria (Owoyemi & Moju, 2020; Owoyemi & Adesina, 2020; Owoyemi & Umanah, 2019; Agbayewa et al, 2013). Furthermore, literature revealed a limited record of previous study in ascertaining the influence of gender on Chemistry teachers' knowledge of GC in Nigeria. This study, therefore, focused on examining the role of gender on Senior Secondary Chemistry teachers' knowledge of Green Chemistry in promoting environmental sustainability.

Research Hypotheses

This study tested the following hypotheses:

1. There is no significant difference in the perceived knowledge of Green Chemistry by male and female Chemistry teachers.
2. There is no significant difference in the measured knowledge of Green Chemistry by male and female Chemistry teachers.

Methods

The study adopted descriptive survey research design with the target population comprising all the Chemistry teachers in secondary schools in Lagos State. the simple random sampling technique was employed to select four educational districts out of the six districts in Lagos State. Two (2) Local Government Areas (LGAs) were randomly selected from each of the sampled districts making up a total of eight (8) LGAs and twenty (20) Chemistry teachers were selected from the secondary schools in each LGA using the purposive sampling method. Hence, the total sample used for the study was one hundred and sixty (160) Chemistry teachers. The instrument used

for the study was a questionnaire titled "Teachers' Knowledge of Green Chemistry Questionnaire" (TKGCQ). It was used to elicit information about the knowledge of Chemistry teachers of Green Chemistry. The instrument consisted of four sections: Section A comprised the demographic data of the participants such as gender and name of school of teacher. Section B enquired into the participants' perceived knowledge of Green Chemistry. It was adapted from Gerald & Julie (2013). The participants were requested to respond on a four-point scale
(1 = *I have never heard of this term and will not be able to explain it*, 2 = *I have heard about this term but I will not be able to explain what it is really about*, 3 = *I know something about this term and can explain it in general terms and*, 4 = *I am familiar with this term and I will be able to explain it well*). The participants' scores were added to form an aggregated score for perceived knowledge. Section C explored the participants' actual content knowledge of Green Chemistry using 10-item multiple choice questions on Green Chemistry concept and principles which were adapted from the American Chemical Society Green Chemistry High School Test Questions (www.acs.org/greenChemistry).The questions were used to determine participants' in-depth content knowledge of Green Chemistry while the number of correct answers revealed a measured knowledge score. The face and content validity of the instrument was authenticated by experts in items development and Chemistry Education. Their comments and suggestions were considered in the final draft. The reliability of the perceived knowledge (Section B) was established using Cronbach's alpha which gave a coefficient of 0.71 while that of the measured knowledge (Section C) was determined using Kuder-Richardson 20 (used to ascertain the reliability of achievement test) method which gave a coefficient of 0.68. The researchers visited the sample schools and administered the instruments to the respondents. Copies of the questionnaire were carefully administered and retrieved on the spot through with the permission of the school authorities and the respondents. The data collected were analysed in line with the stated research hypotheses in the study. The two hypotheses formulated were tested with the independent sample t-test statistic at 0.05 levels of significance.

Results

Table 1: Independent sample t-test of the difference in Chemistry teachers' perceived knowledge of GC based on gender

Variable	Gender	N	Mean	SD	t	Sig
Measured Knowledge	Male	93	2.61	0.873	1.876	0.063
	Female	67	2.36	0.811		

Table 1 showed a t value of 1.876 and a p-value of 0.063 which indicated that the null hypothesis was retained ($p > 0.05$). By implication, there was no perceived significant difference in the knowledge of Green Chemistry between the male and female secondary school teachers in Lagos State.

Table 2: Independent sample t-test of the difference in Chemistry teachers' measured knowledge of GC based on gender

Variable	Gender	N	Mean	SD	t	Sig
Measured Knowledge	Male	93	4.59	2.158	2.713	0.007
	Female	67	3.64	2.220		

Table 2 showed a t value of 2.713 and a p-value of 0.007 which indicated that the null hypothesis was rejected ($p < 0.05$). Consequently, a significant difference existed between male and female Chemistry teachers in their measured knowledge of Green Chemistry. By implication, the male teachers seemed to have better measured knowledge of Green Chemistry than their female counterparts.

Discussion of Findings

This study investigated the role of gender on the perceived and actual knowledge of Green Chemistry possessed by Secondary School Chemistry teachers in Lagos State, Nigeria. The study revealed that both male and female teachers had a low perception of GC and no statistically significant difference in their perceived knowledge. It indicated that they both had similar views about Green Chemistry. The findings were in contrast with the findings of Mostafa (2007) which revealed that significant differences existed between men and women when it came to their perceived knowledge of environmental issues.

The study also revealed that both genders possessed below average content knowledge, with the male teachers having a higher mean score that was statistically significant than their female counterparts. Similar studies carried out by previous researchers revealed similar findings. For instance, Dahlia et al (2017) reported that gender influenced environmental knowledge of teachers, with the men possessing higher knowledge than the women. Tikka et al., (2000) found that the environmental knowledge of teachers apparently depended on gender as male teachers possessed a higher level of knowledge than the female teachers. Also, Brigg's et al., (2003) found that women had limited environmental knowledge than men.

Conclusion

This study revealed that both male and female teachers possessed insufficient knowledge of Green Chemistry. Although they both had similar viewpoints about GC, but there was a significant variation in their actual or measured content knowledge, with males having a higher level of content knowledge than their female counterparts. It could therefore, be concluded that gender significantly influenced the Chemistry teachers' knowledge of Green Chemistry. Regardless of gender, every teacher is expected to obtain adequate knowledge of GC because it will enable effective integration of environmental issues in the teaching and learning of Chemistry, and also adequately educate school children on the importance of GC.

Recommendations

The following recommendations were made based on the findings:

Policy makers should embrace the need to integrate Green Chemistry principles into teacher education programme/curriculum while relevant capacity building workshops/seminars and in-service training programmes should be provided or made

available for Chemistry teachers at all levels (secondary and higher institutions). This should be more opportunities for female teachers to acquire adequate knowledge of GC.

Knowledge of Green Chemistry or sustainable Chemistry or what is regarded as environmentally safe chemical activities should also be considered as part of the requirements for Chemistry teachers' certification regardless of gender as soon as possible.

Instead of putting so many precautionary measures in place when conducting practical activities that involve the use of dangerous/harmful/toxic chemical, rather, serious attention of the Chemistry teachers should acquire adequate and relevant knowledge of GC as it can lead to the adoption of its principles for safer and more efficient laboratory working environment and hence, sustainable environment at large.

References

Agbayewa, J.O., Oloruntegbe, K.O., & Alake, E.M. (2013).Incorporating Green Chemistry Concepts into the Senior Secondary School Curriculum. *International Journal for Cross-Disciplinary Subjects in Education*, 3, 1490-1494.

Arcury, T. (1990). Environmental attitudes and environmental knowledge. *Human Organization,* **49**, 300–304. American Chemical Society (*.ACS). Green Chemistry High School Test Questions.* Available at:www.acs.org/greenChemistry

Anastas, P.T. (2003). Meeting the challenges to sustainability through green Chemistry. *Journal of the Royal Society of Chemistry.* Retrieved from www.greenChemistryandcommerce.com on June 23, 2016. DOI: 10.1039/b211620k

Bloodhart, B. & Swim, J. (2010). Equality, Harmony, and the Environment: An ecofeminist approach to understanding the role of cultural values on the treatment of women and nature. *Ecopsychology*, 2, 187-194.

Briggs, J., Sharp, J., Hamed, N. &Yacoub, H. (2003) Changing women's roles, changing Environmental knowledge: evidence from Upper Egypt. *The Geographical Journal*, 169, 313–325.

Cutter-McKenzie., & Smith, R. (2003). Ecological literacy: the missing paradigm in*Environmental education. Environmental Education Research,* 9(4), 497-524.

Dahlia,S. Agus P &Anggi O. (2017) *Environmental Knowledge and Environmental Friendly Behaviour Based onGender and Education level. International Journal of Advanced Research 1-9.*

Gendall, P. & Smith, T. (1995) Knowledge of scientific and environmental facts: a comparison of six countries. *Marketing Bulletin*, **6**, 65–73.

Gerald, E. & Julie, D. (2013). Education for sustainability: A case study of pre-service primary teachers' knowledge and efficacy. *Australian Journal of Teacher Education*, 38, 3.

Klinge, & Bosch, E. (2001): Gender in Research: Quality of Life and Management of Living Resources.Gender Impact Assessment of the Specific Programmes of the Fifth Framework Programme.

Mostafa, M.M. 2007. Gender differences in Egyptian consumers' green purchase behaviour: the effects of environmental knowledge, concern and attitude, International Journal of Consumer Studies, 31, 220-229.

Nolan, J. M., Schultz, W., Cialdini, R. B., Goldstein, N. J., &Griskevicius, V. (2008). Normative social influence is underdetected. Personality and Social Psychology Bulletin, 34, 913- 923.

Sandilands, C. (1998). The good-natured feminist: Ecofeminism and democracy. In R. Keil, D. Bell, P. Penz, & L. Fawcett (Eds.), Political ecology: Global and local (pp. 235-249). London: Routledge.

Tikka, P.M., Kuitunen, M.T.,Tynys, S.M. (2000). The effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. *Journal of Environmental Education*, 31, 12-19.

Owoyemi, T. E. & Adeleke, S. A., (2020).Pre-service and in-service Chemistry teachers' knowledge and attitude to green Chemistry in Lagos State, Nigeria. *Journal of Curriculum and Instruction,* 1(3) 1, 22-33.

Owoyemi, T. E. & Moju, M., (2020). Investigating Chemistry teacher's 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,* 1(3) 1, 57-71.

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