



Original Article

Teachers' Knowledge of Green Chemistry in Senior Secondary Schools in Kwara State, Nigeria

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Abstract: There have been series of advocacies all over the world to prepare future scientists who would take up the challenge of eradicating environmental pollution through the deployment of scientific knowledge such as green chemistry. This study investigated teachers' knowledge of green chemistry in Kwara State, Nigeria. The Green Chemistry Knowledge Questionnaire (GCKQ) was used to collect the data. Answers were provided to the research questions using the mean and percentage, while the research hypotheses were subjected to t-Test and ANOVA. Findings from the study revealed that the teachers' knowledge of green chemistry was high and significantly higher among experienced teachers. It is recommended that the chemistry teachers should endeavor to pass green chemistry ideas to the students and that the experienced chemistry teachers should carry the less experienced teachers along in the course of passing across the knowledge of green chemistry.

Keywords: Green chemistry, secondary schools, teachers, Nigeria.

1. Introduction

The planet earth is undergoing enormous environmental changes as a result of over exploitation of the earth's natural resources and inappropriate waste disposal among other challenges. This requires an understanding of scientific knowledge to proffer solutions to these issues. According to Booth [1], scientific knowledge is necessary because it allows for

the understanding of most concepts and also offers an explanation of how natural processes in the world operate. Scientific knowledge is acquired through any of the three basic science subjects of chemistry, physics and biology. However, chemistry (the central science) creates the avenue for environmental knowledge to be acquired. This is because chemistry gives the understanding of how chemical substances interact with the natural environment and how human activities cause harmful reactions that pollute the environment.

From industrial waste to domestic waste, a lot of toxic, yet controllable toxins have been

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released into the environment and have impacted negatively on human health [2]. In Nigeria, for instance, 17.2 billion cubic metres of natural gases are flared annually, and it seems that no environmental law has been enforced to re-inject or re-utilise these gases into the reacting systems [3]. This action releases tons of unwanted gases into the atmosphere.

In recent years, however, green chemistry has been established to play an integral role in moving the society toward a more positive and sustainable direction because it offers and

proposes a practical solution to the issues threatening the environment. Green chemistry has been defined as a process of utilizing of a set of chemistry-oriented principles that reduce or completely eliminate the generation of toxic substances in the manufacture, design, invention and application of chemical products [4]. According to Orimogunje [5], green chemistry aims at preventing pollution right from its source rather than having to deal with its resultant debilitating effects on the environment after it has occurred.



Figure 1. Nigeria's Gas Flaring in the Niger Delta.

Source: <https://tinyurl.com/y43krawk>

It is also noteworthy that the practice of green chemistry is a lot cheaper than having to take care of the resultant effects of its non-practice. It is therefore of utmost importance that the knowledge of green chemistry is efficiently transmitted to tackle the problems threatening the environment. Green chemistry knowledge involves understanding all the twelve principles of green chemistry as listed by the United States Environmental Protection Agency [6]. These principles involve the understanding of processes that could be used to curtail the use and generation of toxic substances. These include:

i) Prevent waste: Design chemical syntheses to prevent waste. Leave no waste to treat or clean up;

ii) Maximize atom economy: Design syntheses so that the final product contains the maximum proportion of the starting materials. Waste few or no atoms". (See The United States Environmental Protection Agency, 2017 <https://www.epa.gov/greenchemistry/basics-green-chemistry#twelve> for full list).

Chemistry teachers are expected not only to be familiar with these principles, but to apply them and transmit the knowledge and application of the principles to their students. As a major stakeholder in the education sector, the science teacher is expected to bring into the classroom, learning experiences that will be beneficial, worthwhile and applicable in most situations [7]. To do so, they need to be adequately trained and skilled, obtain the required qualification and

needed experience to effect the required change in their students. Chemistry teachers therefore represent a critical vessel through which the current global advocacy for green chemistry could be disseminated.

Oloruntegbe and Agbayewa [8] suggested the integration of green chemistry into the Nigerian senior school chemistry curriculum. This, according to them, would encourage the youths to develop environmental consciousness and accountability very early in their academic pursuit. This integration, they believed, would be in line with the trend worldwide and also enable the Nigerian schools to train and produce chemists and industrialists who would adopt more environmental-friendly policies that could engender a safer environment. However, as important as green chemistry is, it becomes irrelevant if not effectively taught by teachers who are expected to train and nurture future scientists who would ensure a safe environment for all. Do these teachers possess the knowledge of green chemistry? Do the teachers have the academic capacity to “green” all the chemistry lessons and experiments carried out in the laboratories? It is on this basis that this research investigated the chemistry teachers’ knowledge of green chemistry as they prepare future chemists and scientists for the challenges ahead.

The Nigerian education system is structured into three main strata; Basic Education, Post-Basic Education and Tertiary Education. Basic Education is the education provided to children from infancy to around fifteen years. It encompasses the education provided in: the Kindergarten Schools (one year), the Primary (Elementary) schools (six years), and the Junior Secondary Schools (three years). By law, every Nigerian parent is expected to ensure that his child or ward receives Basic Education. Post-Basic education is the education received by children after a successful completion of ten years of Basic Education, and upon passing the required Basic Education Certificate Examination. It is the education given to children in the Senior Secondary Schools. It lasts for three years. Chemistry is one of the science subjects taught at this level of

education. Others science subjects are Biology, Physics, Health Education, Agriculture, Physical Education, and Computer Studies. Nigeria is a federation and the same education curriculum is implemented nationwide. Hence, the same education structure that operates in Kwara State operates in every part of Nigeria.

It is particularly important that studies on green chemistry be conducted in developing countries like Nigeria because a lot of chemical wastes that are being generated are not being properly managed. We all live in one earth and the impact of an environmental problem in one place can have a global effect. For instance, plastic containers that find their way to the oceans in Nigerian can be transported as far as anywhere on the planet where they can distort the aquatic ecosystem.

The study went ahead to examine the influence of teachers’ academic qualification and length of professional experience as well as school type on their knowledge of green chemistry. At the Nigerian senior secondary school level, a qualified teacher is one who possesses a teaching certificate, has at least a Bachelor’s degree in education or a Bachelor’s degree in a particular subject and a Postgraduate Diploma in Education (PGDE) in addition, and is well versed in his/her area of specialization and subject matter. However, there are some teachers who are not professionally qualified. Such teachers hold a Bachelor of Science (As against Bachelor of Science Education) degree in Chemistry or other science-based disciplines but have found themselves teaching without teaching certification due to lack of jobs. Eryilmaz and Laslan [9] indicated teachers’ qualification as one of the most critical factors to students’ achievement. This study sought to find out whether there would be significant disparities in the knowledge of green chemistry possessed by qualified teachers and unqualified teachers so that appropriate remedies could be advocated.

Teachers’ length of teaching experience is another factor that could bring about a desired change in the knowledge being passed on to the students. According to Rice [10], the experience

earned over time enhances the knowledge, skills and productivity of teachers. This study sought to find out whether this experience influenced teachers' knowledge of green chemistry.

Within the context of this study, public schools are those schools that are established and funded by government while private schools are those established and funded by non-government establishments. The non-government establishments include private individuals, religious bodies and non-governmental organisations (NGOs). Many empirical studies have been conducted to find out disparities between these two groups of schools with a view to bridging the gap in the standard of education being offered in the schools. Whether such disparities exist in terms of the green chemistry knowledge of the teachers was also part of the focus of this study. Studies related to these variables are reviewed in the literature review.

2. Literature Review

The American Chemical Society [11] described green chemistry as a relatively new phenomenon, hence, empirical studies on green chemistry as it relates to teachers and students are very rare. It would take a few years more before studies in this area would be more visible in the academic space. However, studies around the two major moderating variables associated with this study are readily available.

Even though Chen, Jeronen and Wang [12] did a comprehensive literature review with a view to identifying appropriate pedagogical approaches to teaching and learning green chemistry among college students and pre-service teachers, the reviewed works are expository essays with focus on green chemistry learning programmes review, course designs, evaluations, instructional methods descriptions, and activity reports among others [13-17].

The review by [12] was carried out by inquiring into the instructional methods that were being used to facilitate green chemistry education, and how these methods have

reinforced the learning of green chemistry. Forty five peer journal articles were reviewed. The review revealed that collaborative and interdisciplinary learning, and problem-based learning were the most frequently used teaching methods, amongst others. These teaching methods were reflected in 38 and 35 articles, respectively.

One empirical study on green chemistry and its learning is the study conducted by Auliah and Mulyadi [18]. They sought to find out teachers' knowledge and perceptions of green chemistry and its integration into the learning process in a Chemical Analyst Vocational School in Makassar, Indonesia. In their study, a questionnaire on the subject was used to elicit responses from 35 teachers in the school. The results showed that while majority of the respondents (97.14%) reported knowledge of green chemistry, only 32.30% of them indicated awareness of the concept of green chemistry. Furthermore, while 47.42% of the teachers felt that green chemistry needs not be inserted into learning curriculum, 31.38% felt the need to include it.

Martneau [19] submitted that teachers have enormous influence on the way students learn, what they learn, the extent of the learning, their interpersonal interactions as well and how they interact with their environment. Hence, it is expected that a qualified teacher would bring into the classroom, certain qualities that would bring about the desired change in students' performance. Many studies available in the literature have indicated that teachers' educational qualifications and experience significantly influenced the academic achievement of students. Aina and Olanipekun [20] sought to find out the influence of teachers' qualification on students' academic achievement on the basis of existing research reports. In their work, teachers' qualification was determined around seven indicators, i.e. formal education, subject matter knowledge, experience, duration of training, pedagogy studies, professional development and certificate/licensing. Of these indicators, pedagogy studies, subject matter knowledge,

years of experience, professional development and were found to correlate positively with students' achievement in school subjects. The researchers viewed a teacher's number of years of experience as part of his qualification.

In a study conducted by Yusuf and Dada [21] to find out the impact teachers' qualification and experience have on College of Education students' performance in English language, the English language scores of students taught by professionally qualified teachers and non-professionally qualified teachers were statistically compared. Similarly, the performances of the students were also analysed on the basis of the experience of their teachers. It was revealed that students taught by professionally qualified teachers performed better in English language than students taught by non-professionally qualified teachers. Findings further revealed better performance by students taught by more experienced teachers. Similarly, Fakeye [22] conducted a study on teachers' qualification and subject mastery and found out that teachers' teaching qualification significantly impacted on students' academic achievement in English Language. Still in the subject of English language, Adeyemi [23] reported a better students' performance in the subject when taught by qualified English language teachers over their counterparts who were taught by non-qualified English language teachers.

In the subject of Mathematics, a report on the effect of teachers' qualification on students' performance in Mathematics by Abe [24] showed that students taught Mathematics by professional teachers performed significantly better than students taught by non-professional teachers. Presenting the result of a study conducted to find out the influence of teachers' qualification on the Mathematics section of the Alabama Reading and Math Test (ARMT) for Middle Schools, it was reported by Richardson [25] that teachers' qualification related to students' achievement significantly. Ogbonnaya [26] later asserted that students taught by Mathematics teachers who have five years teaching experience are likely to improve significantly in their Mathematics achievement.

A research study carried out by [27] in two Local Government Areas in Delta State showed that the quality of the teachers and the instructional strategies they used influenced students' achievement significantly in science. Similarly, [28] established significant relationship between the academic qualifications of Chemistry teachers and the achievement of their students in Chemistry. A similar result was reported in Biology by [29] who affirmed that the professional qualification of Biology teachers enriched the achievement of the students in the subject. Boyd et al., [30] indicated in their study that when teacher qualifications improved, it was complemented with a corresponding improvement in students' achievement in school subjects. Similarly, [31] reported that the dearth of qualified teachers contributed to the persistent dismal performance of students in Science, Mathematics and Technology subjects in Nigeria. Similar results were obtained by [32-36].

In contrast to these studies, a study conducted in Kenya by [37] indicated no significant relationship between teachers' qualifications and students' performance in Science, Technology and Mathematics. The ex-post facto study involved eight school heads, 40 science, mathematics and technology teachers and 600 secondary school students who had sat for the Kenya Certificate of Secondary Education (KCSE) Examination in 2012. This finding has a similarity to those of other [38-42] who found out that the educational level and number of years of teaching experience of teachers did not influence students' academic performance significantly.

It has also been established in literature that teacher's teaching experience corresponds positively with students' learning outcome. For instance, Raw [43] confirmed that teachers with more years of teaching experience produced more students with better academic achievement. Expectedly, when teachers are highly experienced, they should master not only their subject content, but the appropriate pedagogy for the various topics in the subject. They are equally expected to be able to handle any challenges that may arise in their attempt at

getting the students understand their subject. To support this claim, Akinsolu [44] said that teachers' experience is an important pre-requisite for students in attaining their desired educational dreams.

Dial [45] studied the effect of teacher experience on students' achievement and reported that teachers' number of years of teaching experience influenced students' achievement in Communication Art and Mathematics significantly. In another study, [44] reported that teachers' qualification, experience and teacher-student ratio contributed significantly to the academic achievement of the students. A study by [10] indicated that teachers' experience impacted significantly in the early years of teaching by a teacher and subsequently diminished in significance with time. Ladd and Sorensen [46] also reported that teachers' experience impacted positively on students' achievement and motivation in middle school.

In Nigeria, [47] reported in their study that teachers' experience had significant impact on students' academic performance in English language and Mathematics and as measured by their performances in the Senior School Certificate Examination. They reported that schools that had more of its teachers having 10 years teaching experience produced better results than other schools dominated by teachers who were less experienced. However, a study by [48] revealed no significant association between teacher's experience and students' achievement.

Many studies have examined disparities between public and private schools based on certain variables. However, studies comparing teacher characteristics in both sectors are not common. Frenette and Chan [49] examined the influence of student characteristics, peer effects, province fixed effects and school resources and practices on the academic achievements of students in private and public high schools in Canada. The study revealed that students in the private high schools achieved higher

significantly than their public school counterparts in mathematics, science and reading. The differences were found to be associated with the better socio-economic background of the students in the private schools as well as the fact that they have peers whose parents had university education.

Olasehinde and Olatoye [50] did a comparative analysis of the achievement of public and private senior secondary school students in science in Katsina State, Nigeria. The study which involved two hundred and four (204) senior secondary school students reported that private school students achieved significantly better than their public school counterparts in science. However, while they reported no significant difference between private and public school students' achievement in chemistry and biology, the achievement of students in the private schools was comparatively better than that of their counterparts in the public schools.

Sherafat and Murthy [51] sought to find out whether differences exist in the critical thinking and study habits of students in public and private schools in Mysore, India. They found out that students in the private schools possessed better critical thinking and study habits than their counterparts in the public schools. One study that focused specifically on a teacher characteristic is that of Buka and Bilgic [52]. In their study, they sought to find out whether differences existed in the job attitudes of public and private school teachers in Albania. Data were obtained from 429 teachers (254 from public and 175 from private schools). The result of the data analysed using ANCOVA indicated that the private school teachers were more committed and more satisfied with their jobs than the teachers in the public schools.

The predominant position from this literature review is that teachers' qualification and experience influence students' achievement significantly across subjects. Yet, the few studies that have contradicted this position still

leave the subject open for research, hence, the consideration given to these variables in this particular study. So also, on the basis of the reviewed literature across the globe, things seem to be better in private schools than in public schools.

3. Purpose of the Study

The main purpose of this study was to find out teachers' knowledge of green chemistry in senior secondary schools in Kwara State. Specifically, the study sought to find out:

- i) Chemistry teachers' knowledge of green chemistry;
- ii) Influence of teachers' academic qualification on their knowledge of green chemistry;
- iii) Influence of teachers' length of professional experience on their knowledge of green chemistry;

4. Influence of school type (public and private schools) on their knowledge of green chemistry.

4. Research Questions

In line with the stated purposes, answers were sought to the following research questions:

1. What is the level of the chemistry teachers' knowledge of green chemistry?
2. Does the teachers' qualification influence their knowledge of green chemistry?
3. Does teachers' knowledge of green chemistry vary among experienced, moderately experienced and less experienced chemistry teachers?
4. Does teachers' knowledge of green chemistry vary between teachers in public schools and their counterparts in private schools?

5. Research Hypotheses

The following research hypotheses were tested in this study:

- i) HO₁: There is no significant difference in the knowledge of green chemistry possessed by qualified and unqualified chemistry teachers;

ii) HO₂: There is no significant difference in the knowledge of green chemistry possessed by experienced, moderately experienced and less experienced chemistry teachers;

iii) HO₃: There is no significant difference in the knowledge of green chemistry possessed by chemistry teachers in public schools and their counterparts in private schools.

6. Research Method

Chemistry teachers from both public and private schools were purposively selected from Kwara Central Senatorial District out of the three Senatorial Districts in Kwara State, Nigeria. This is because available data showed that there were more chemistry teachers in the district. 270 teachers were targeted for the research but a total number of 210 chemistry teachers successfully responded to the research and this included 126 chemistry teachers from the public schools and 84 chemistry teachers from the private schools. The Green Chemistry Knowledge Questionnaire (GCKQ), a twenty item list on green chemistry knowledge, was used to gather data. The items were adapted from Reinhardt [53] guidebook on applying green chemistry principles to laboratory operations and Beyond Benign curriculum mapping for high school chemistry students. The GCKQ had response modes of Very True (VT), True (T), Not So True (NT) and False (F) and numerical values of 4, 3, 2 and 1 were respectively assigned to the response modes for analysis. Some of the items in the research instrument to which respondents provided response include: Global warming is caused by human activities; O₂, N₂O, CO₂ and CFC are all green house gases; It is the artificial increase in some atmospheric gases that lead to global warming; Lead, cadmium and mercury should be characterized as toxic elements etc.

The face and content validity of the research instrument was carried out by two senior experts in Science Education at the University of Ilorin and three senior lecturers

from the Department of Chemistry in the same university. Suggestions and corrections made were utilized to enhance the instrument before the reliability test was carried out. The instrument was then administered to 25 respondents outside the population of study, to ascertain its reliability index. Cronbach's Alpha statistic was used and a reliability index of 0.71 was obtained.

The researchers visited the schools to issue out letters of introduction to the principals seeking their approval to engage the chemistry teachers in the study. Informed consent forms were also issued to the chemistry teachers who partook in the research. After the preliminary introduction and explanation of the researcher's intention, the instruments were administered to the chemistry teachers. Some filled questionnaires were collected the same day while the others were collected at a later date. Analysis of the data obtained in respect of the research questions was done using mean and percentage and the hypotheses were put to test using t-Test and Analysis of Variance (ANOVA). Hypotheses 1, and 3 were tested using t-Test statistic while hypotheses 2 was tested using ANOVA at 0.05 level of significance. Version 20.0 of the Statistical Package for Social Science (SPSS) was used for the analysis.

7. Data Analysis and Results

Research Question 1: What is the level of the chemistry teachers' knowledge of green chemistry?

The grading format of the level of knowledge of green chemistry is as follows:

Low level = 0 – 2.0

Average level = 2.1 – 3.0

High level = 3.1 – 4.0

Table 1 shows the mean score of the level of the teachers' knowledge of green chemistry as 3.33. This means that the level of the chemistry teachers' knowledge of green chemistry was high.

Research Question 2: Does the teachers' academic qualification influence chemistry teachers' knowledge of green chemistry?

Hypothesis 1 (HO₁): There is no significant difference in the knowledge of green chemistry possessed by qualified and unqualified chemistry teachers.

Table 1. Level of chemistry teachers' knowledge of green chemistry

N	Mean	SD
210	3.33	0.43

Table 2 indicates that the mean score of the qualified teachers is not too different from that of the unqualified teachers. The qualified teachers had a mean score of 3.34, while the unqualified teachers had a mean score of 3.30. The t value shows that there is no significant difference between the knowledge of green chemistry possessed by the qualified teachers and the unqualified teachers, $t(187) = 0.57$, $p > 0.05$. Since the p -value (0.56) was greater than 0.05 level of significance, the null hypothesis was not rejected.

Research Question 3: Does teachers' knowledge of green chemistry vary among experienced, moderately experienced and less experienced chemistry teachers?

Hypothesis 2 (HO₂): There is no significant difference in the knowledge of green chemistry possessed by experienced, moderately experienced and less experienced chemistry teachers.

Table 3 reveals that the experienced teachers had the highest mean score of 3.51, while the moderately experienced teachers and the less experienced teachers had mean scores of 3.30 and 3.26 respectively. It is evident that the knowledge of green chemistry possessed among the experienced teachers, the moderately experienced teachers and the less experienced teachers vary, with the knowledge of green chemistry increasing with teachers' experience. The more experienced the teachers were, the more their knowledge of green chemistry.

Table 2. t-Test analysis presenting the knowledge of green chemistry between unqualified and qualified chemistry teachers

Groups	N	Mean	SD	df	t-Test	p-value	Decision
Unqualified teachers	39	3.30	0.35	187	0.57	0.56	HO ₁ not Rejected
Qualified teachers	150	3.34	0.45				

$p > 0.05$, Not Significant.

The ANOVA result on table 3 shows a statistically significant difference among the less experienced, moderately experienced and the experienced chemistry teachers, $F(2, 187) = 4.77$, $p < 0.05$. The post-hoc Scheffe test on table 4 also reveals a statistically significant difference between the experienced group and

the moderately experienced group (Mean Difference = - 0.21) and between the experienced group and the less experienced (Mean Difference = - 0.25). Since the p-value (0.01) was less than 0.05 level of significance, hypothesis 2 was rejected.

Table 3. ANOVA analysis showing knowledge of green chemistry among less experienced, moderately experienced and experienced chemistry teachers

Groups	N	Mean	SD	df	p-value	F	Decision
Less experienced	65	3.26	0.40	2,186	0.01	4.77	HO ₂ Rejected
Moderately experienced	84	3.30	0.48				
Experienced	40	3.51	0.34				

$P < 0.05$, Significant

Table 4. The post-hoc Scheffe test showing differences among the experienced, moderately experienced and the less experienced teachers

(I) Years of Teaching Experience	(J) Years of Teaching Experience	Mean Difference (I-J)	Std. Error	Sig.
Below 5 years	5 - 10 years	-0.04255	0.07023	0.832
	Above 10 years	-0.25327*	0.08544	0.014
5 - 10 years	Below 5 years	0.04255	0.07023	0.832
	Above 10 years	-0.21071*	0.08167	0.038
Above 10 years	Below 5 years	0.25327*	0.08544	0.014
	5 - 10 years	0.21071*	0.08167	0.038

Research Question 4: What influence does school type have on chemistry teachers' knowledge of green chemistry?

Hypothesis 3 (HO₃): There is no significant difference in the knowledge of green chemistry possessed by chemistry teachers based on school type.

Table 5 shows that the public school teachers had an almost equal mean score to that of the private school teachers. Mean scores of 3.36 and 3.30 respectively were recorded for

the public and private school teachers. The scores of the chemistry teachers in the public schools ($M = 3.36$, $SD = 0.49$) is almost similar to those of the teachers in the private schools ($M = 3.30$, $SD = 0.32$). The t-Test analysis revealed no statistically significant difference in the knowledge of green chemistry possessed by the chemistry teachers in both the public and private school, $t(208) = 1.023$, $p > 0.05$. Hence hypothesis 3 was not rejected because the p-value (0.31) is greater than 0.05 level of significance.

Table 5. t-Test analysis showing the knowledge of green chemistry of chemistry teachers in public and private schools

Groups	N	Mean	SD	df	t-Test	p-value	Decision
Public schools	126	3.36	0.49	208	1.023	0.31	HO ₃ Not Rejected
Private schools	84	3.30	0.32				

$p > 0.05$, Not Significant.

8. Summary of Findings

From the results obtained from the analyses, the following were observed:

i) The level of the green chemistry knowledge possessed by the chemistry teachers was high. The mean score obtained was 3.33 out of a maximum score of 4.0;

ii) The mean score of the qualified teachers (3.34) was not too different from that of the unqualified teachers (3.30). t-Test revealed that there was no significant difference in the knowledge of green chemistry possessed by the qualified and the unqualified chemistry teachers $t(187) = 0.57$, $p > 0.05$. Hypothesis 1 was therefore not rejected. It was clear that the chemistry teachers' academic qualification did not influence their knowledge of green chemistry significantly;

iii) The experienced teachers had the highest mean score of 3.51, while the moderately experienced teachers and the less experienced teachers had mean scores of 3.30 and 3.26 respectively. The more experienced the teachers were, the more their knowledge of

green chemistry. ANOVA statistic showed that there was a significant difference in the knowledge of green chemistry possessed by the experienced, moderately experienced and less experienced chemistry teachers, $F(2, 187) = 4.78$, $p < 0.05$. The post-hoc Scheffe test also revealed that there was a significant difference between the experienced teachers and the moderately experienced teachers and also between the experienced teachers and the less experienced teachers. Hence, hypothesis 2 was rejected.

The public school teachers had an almost equal mean score (3.36) to that of the private school teachers (3.30). t-Test statistic also showed that school type did not have any significant influence on the knowledge of green chemistry possessed by the chemistry teachers, $t(208) = 1.02$, $p > 0.05$, hence hypothesis 3 was not rejected.

9. Discussion of Findings

From the results obtained, the level of the teachers' knowledge of green chemistry was

high. This is similar to the findings of [18] who reported that 97.14% of the teachers who served as respondents in their study reported knowledge of green chemistry. The teachers involved in this current study definitely had exposure to some elements of green chemistry during their professional training and seem to have retained the knowledge. Even though the green chemistry knowledge possessed by the qualified teachers was slightly higher than that of the unqualified chemistry teachers, inferential statistic revealed that this difference was not significant.

Possessing the knowledge of any subject matter is a crucial factor in a teacher's ability to transmit the knowledge to others. If a teacher has no thorough understanding of a concept, he cannot teach it successfully to students and this will impact negatively on their achievement. The implication of this finding therefore is that the teachers should be able pass on the appropriate knowledge of green chemistry to their students for practice. The result also indicates that the ability of the qualified and unqualified Chemistry teachers to pass the knowledge of green chemistry to learners may not differ significantly, and by extension, there may be no significant difference in the achievement of the students if examined on their knowledge of green chemistry after they have been taught by these two groups of teachers, especially if we go by the findings of [37-42].

However, there was a significant difference in the knowledge of green chemistry possessed by the experienced teachers and each of the other two groups (the moderately experienced and the less experienced). The experienced teachers, with over ten years of teaching experience, had the highest mean score. Going by the submission of previous researchers [10] [44-47] on the impact of teacher experience on students' achievement which revealed that the experience earned overtime enhances the knowledge, skills and productivity of the teachers, it is expected that the teachers' experience which has positively influenced their knowledge of green chemistry will equally

have a similar effect on their ability to deliver green chemistry principles to the students.

The result from the last hypothesis on knowledge of green chemistry based on school type revealed that school type did not influence the knowledge of green chemistry possessed by the chemistry teachers significantly. Teachers in the public schools were found to have a better knowledge of green chemistry than their colleagues in the private school, but the difference was not significant. This is probably because most teachers received similar formal training in college, and are also equipped with similar teaching skills that will aid learning and teaching wherever they find themselves. This particular finding does not go the way of those studies on public and private schools earlier reviewed in this work.

10. Conclusion

The results obtained from this study revealed that the level of the chemistry teachers' knowledge of green chemistry was high. Academic qualification and school type did not influence the green chemistry knowledge possessed by the chemistry teachers significantly, but teachers' years of experience did have a significant influence on the knowledge of green chemistry possessed by the chemistry teachers.

11. Recommendations

The following recommendations are made from the findings of this study:

The chemistry teachers should endeavor to pass green chemistry ideas to the students since they have good knowledge of it.

The experienced chemistry teachers should carry the less experienced teachers along in the knowledge related to green chemistry. They should provide appropriate mentorship for their junior colleagues in the area of green chemistry knowledge.

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