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SCIENCE PROCESS SKILLS ACQUIRED BY SENIOR SECONDARY SCHOOL CHEMISTRY STUDENTS IN QUALITATIVE ANALYSIS IN KEFFI EDUCATION ZONE, NIGERIA

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Abstract

The study was aimed at ascertaining the science process skills acquired by senior secondary school Chemistry students in qualitative analysis in Keffi Education Zone. The sample was made up of sixty (60) secondary school students (SSSIII) from six (6) secondary schools. The design for the study was descriptive survey. The science process skills investigated were observing, experimenting, and controlling variables, measuring, recording, communicating and inference using qualitative analysis. The instrument for data collection was the qualitative analysis skills rating scale (QASRS) adapted by the researchers and validated by the science educators in Nasarawa State University Keffi. The instrument contained twenty (20) qualitative analysis items (QLA). Kendall's co-efficient of concordance was used to establish the inter-rater reliability index of 0.803. The internal consistence reliability coefficient of the instrument was 0.732 using Cronbach's alpha. Data collected were analyzed using mean, standard deviation, Z-test and ANOVA. It was found that students had low level of acquisition in controlling variables, recording, communication and inference. Gender and school type had no significant influence; school location had significant influence in favour of Urban. Among other, it was recommended that pedagogical inspectors, principals and school administrators should be strict on the maximum use of the science laboratory by science teacher.

Keywords:
Chemistry, Science Process Skills, Gender, School Type, and School Location.

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Introduction

Chemistry is a branch of science which deals with study of matter, its structure, composition, properties and changes it undergoes. Chemistry aims at helping learners to acquire appropriate skills, abilities and competencies that would enable them contribute to the development of society (Ojukuku, 2012). Chemistry cannot be isolated from our lives since human beings have always been in contact with chemical substances and technological products such as cosmetics, drugs, detergents/soaps and fertilizer among others. The importance of chemistry as a basic requirement of any nation cannot be over emphasized. According to Anugwo and Asogwa, (2015), chemistry has contributed greatly towards providing our basic needs and improving the quality of life. The knowledge of chemistry has been used in production of fertilizers and insecticides which has in turn increased production of food greatly. Chemical processes are designed especially to preserve and store food for a long period, so that it can be exported to distant countries and is available to many people. Man-Made textile fibers are produced as a result of chemical research and technology. Many high-rise buildings need materials like cement, concrete, steel, bricks and tiles produced by chemical industries. The mechanical properties of these materials are as a result of chemical research. Bleaches, disinfectants and soaps are various chemical products from the knowledge of chemistry. In recognition of important of Chemistry to the society, research for more effective approach for the teaching and learning of science that will enhance the acquisition of process skills has been persisted over the years. This is because the acquisitions of science process skills are the basis for scientific inquiry, development of intellectual skills and attitudes that are needed to learn concepts (Jacks, 2013). Ozgelen (2012) defined science process skills as abilities, potentials as well as all the technical "know how" which can be developed in a child and which can be employed in carrying out mental and physical operation in science. Aydogu (2015) described science process skills as mental and physical abilities and competencies which serve as tools needed for the effective study of science and technology as well as problem solving for individual and societal development. Acquisition of these skills is enhanced by the use of experimental method of teaching which involves child`s active involvement in activities. The shift from the teacher-centered method of teaching science to child- centered activity based method which encourages and develops in the child the spirit of inquiry; an attempt to make students fully aware as well as understand the ways scientist work; and also in equipping and preparing students for their possible careers in science and technology led to the development of process skills (Igboegwu and Okonkwo, 2011).

The American Association for the Advancement of Science (AAAS, 1967) classified the science process skills into fifteen. These are observing, measuring, classifying, communicating, predicting, inferring, using number, using space/time relationship,

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questioning, controlling variables, hypothesizing, defining operationally, formulating models, designing experiment and interpreting data. According to Ango (2011), science process skills can be classified into two categories as basic and integrated process skills. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills. Basic science processes are vital for science learning and concept formation at the primary and junior secondary school levels. More difficult and integrated science process skills are more appropriate at the senior secondary and tertiary school levels for the formation of models, experimenting and inferring. Hence, both basic and integrated science process are relevant and appropriate at the senior secondary school level in Nigeria. This study identified level of acquisition of seven (7) out of the fifteen (15) science process skills. These comprised of five (5) basic science process skills (observation, measuring , recording, communication and inferring skills) and two (2) integrated science process skills (controlling variables and experimenting).

Science process skills acquisition has significance influence on students` practical activities at senior secondary school level where students are required to be evaluated on practical activities as one aspect of the nine papers written in the final examination. This practical test is designed to develop and test the three aspect of the students' intellectual development; cognitive, affective and psychomotor skills. This practical is introduced late and students have to acquire these practical skills in few months to write WAEC and NECO examinations (Okorie&Ugwuanyi, 2019). The late introduction of training in the psychomotor skills at the SSIII may be the cause of poor students` achievement in chemistry practical at SSIII as reported by WAEC Chief Examiner's Report 2018. Chemistry students will have problem of acquiring these practical skills in short period to write the final examination. This might affect the overall achievement of students in O' level chemistry practical. Some reviewed literatures have shown that students have low level of acquisition of science process skills in some skills (Okinuga, Ojo & Yande, 2013 & Ayodgu, 2015).

Apart from late introduction of chemistry practical to students, their acquisition of science process skills in practical work can be influenced by other factors such as gender, school location, school type, etc. Some studies have been carried out to find out the effect of gender, school location and school type in science generally on the acquisition of science process skills in particular. Some researchers have reported the prevalence of significant gender difference in acquisition of science process skills in sciences. For exampleAkinbobola and Afolabi, (2012) and Muhammad (2014) submitted that gender had no significant influence on acquisition of science process skills among the secondary school students in biology. But Njoku and Jacks (2011) andUgwuanyi (2015), found out that gender had significant effect on acquisition of process skills. According to Yusuf (2010) and Akinbobola (2008), urban students outperformed their rural counterparts in

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chemistry achievement test. In contrary, Ezeudu& Obi (2013) and Adigun (2010) found no significant difference between urban and rural schools. On influence of school type on students' achievement in science, literature revealed that females benefited more in single schools than in co- educational schools (Jacks, 2013). In contrary, Yusuf (2010) noted that all male schools performed better on some skills acquisition followed by co-educational schools and least was female schools. Ugwu (2009) and Adigun (2010) found that school type has no influence on practical skills acquisition. These factors which affect science process skills would also affect students' achievement in chemistry practical. It is therefore necessary to identify the science process skills acquired by senior secondary school students in chemistry qualitative analysis to find ways of improving the students' acquisition of the skills if the level is low.

Statement of Problem

Science process skills are useful in science and non-science situations. Process skills are very fundamental to science which allows students to conduct investigations and reach conclusions; but there is still a serious educational gap in this area both in bringing these skills into the classroom and in the training of teachers to use them effectively. Both basic and integrated science process skills are relevant and appropriate for learning science subjects, especially Chemistry practical at senior secondary school level in Nigeria. However, there is consistent poor achievement of students in Chemistry practical at senior secondary school level. Achievement in Chemistry practical is related to the acquisition of science process skills and if the acquisition of these skills is low, achievement will consequently be low. Most importantly, the acquisition of these skills is through laboratory practical activities. Could this poor achievement in Chemistry practical be as a result of the lack of the acquisition of science process skills by Chemistry students during practical activities? Hence, the problem of the study is to identify the level of science process skills acquired by senior secondary school chemistry students in qualitative analysis. Specifically, this study involved identification of the influence of gender, school type and school location on chemistry students` level of acquisition of science process skills in chemistry qualitative analysis.

Research Questions

The following research questions guided the study:

1. What is the level of science process skills acquired by students in qualitative analysis?
2. What is the influence of gender on level of science process skills acquired by students in qualitative analysis?
3. What is the influence of school type on level of science process skills acquired by students in qualitative analysis?

4. What is the influence of school location on level of science process skills acquired by students in qualitative analysis?

Hypotheses

The following null hypotheses were tested at [p< 0.05] level of significance to guide the study.

HO1: There is no statistically significant difference between the mean scores of male and female students on level of science process skills acquired in qualitative analysis.

HO2: There is no statistically significant difference in the mean scores of male, female and co- educational school students on level of science process skills acquired in qualitative analysis.

HO3: There is no statistically significant difference in the mean scores of urban and rural school students on level of science process skills acquired in qualitative analysis.

Methodology

The design of the study was a descriptive survey research design. The area of the study was Keffi Education Zone of Nasarawa Statei. The population of the study consisted of 802 senior secondary three (SSIII) chemistry students in the 27 schools in Keffi Education Zone in 2014/2015 academic year (Statistic Office PPSMB Keffi, 2015). A sample size of 60 SSIII chemistry students from 6 schools was drawn. The research adopted a multi- stage sampling technique. The multi- stage sampling technique consisted of number of distinct stages. The first involves purposive sampling which was used to select the six (6) schools required. The second stage involved proportionate stratified random sampling technique which was used in composing the number of schools based on school location and gender. Finally, simple random sampling through balloting without replacement was used to select ten (10) students from every school sampled in the Education Zone. The instrument for data collection for this study was the qualitative analysis skills rating scale (QLSARS). The instrument consisted of 27 qualitative analysis (QLA) items adapted from (Ugwu, 2009). The raters/teachers rated the students using scale points of: Very Good (VG)–4 points Good (G)-3 points, Fair (F)-2 points and Poor (P)-1 point. The instrument was face validated by three (3) experts in measurement and evaluation and two (2) subject specialists. The trial testing of the instrument was carried out on a representative sample of 10 SS III chemistry students by three chemistry teachers that the researchers trained on the rating of the items. These students were randomly selected from two (2) secondary schools from keffi Education Zone of Nasarawa State. Kendall`s co-efficient of concordance was used to establish the inter-rater reliability value of 0.803, which was adjudged to be high. The internal consistency reliability co-efficient was estimated using Cronbach`s Alpha which yielded a value of 0.732, which was adjudged to be high. Mean

and standard deviation were used to answer the research questions. A mean score of 2.5 and above on a skill were considered to be high level of acquisition of the skills while a mean score of below 2.5 was considered as indicator of low level of RESULTS acquisition of the skills. Z-test and ANOVA were used to test hypotheses at
0.05 level of significance.

Research Question One: What is the level of science process skills acquired by students in qualitative analysis?

Table 1: Mean ($\bar{x}$) and standard deviation (SD) of clusters of qualitative analysis scores on level of science process skills acquired by chemistry students in qualitative analysis.

S/N	Process Skills	No. of Items	No. of Students	$\bar{x}$	SD	Level
1	Observation	6	60	2.84	0.43	**High**
2.	Experimenting	4	60	2.79	0.50	**High**
3.	Controlling variables	5	60	2.91	0.48	**High**
4.	Measuring	2	60	2.64	0.53	**High**
5.	Recording	4	60	2.40	0.95	**Low**
6.	Communication	3	60	2.37	0.89	**Low**
7.	**Inference**	**3**	**60**	**2.48**	**0.89**	**Low**

Table 1 below shows that students generally have low level of acquisition on skills 5, 6 and 7. However, students have high level of acquisition of other skills as shown in table 1.

Research Question Two: What is the influence of gender on level of science process skills acquired by students in qualitative analysis?

Table 2: Mean ($\bar{}$) and standard deviation (SD) of clusters of qualitative analysis scores on level of science process skills acquired by male and female chemistry students in qualitative analysis.

S/N	Process Skills	No. of Items	$\bar{x}$m	SDm	Level	$\bar{x}$f	SDf	Level
1.	Observation	6	2.97	0.40	High	2.71	0.46	**High**
2.	Experimenting	4	2.88	0.46	High	2.70	0.54	**High**
3.	Controlling variables	5	2.98	0.43	High	2.84	0.53	**High**
4.	Measuring	2	2.77	0.58	High	2.51	0.48	**High**
5.	Recording	4	2.43	0.99	Low	2.37	0.91	**Low**
6.	Communication	3	2.42	0.87	Low	2.32	0.91	**Low**
7.	Inference	3	2.53	0.88	High	2.43	0.90	**Low**
	Overall Mean		**2.71**	**0.66**	**High**	**2.55**	**0.81**	**High**

No. of male students 30 No. of female students 30

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Table 2 shows that the male students had high level of acquisition of science process skills in qualitative analysis than those of female students as can be deduced from their high overall mean score of 2.71 when compared to
2.55 of the female students. However, hypothesis one was tested to see if this difference is significant. Both male and female students had high level of acquisition on skills 1, 2, 3 and 4 and low level on skills 5 and 6.Male students had high in skill 7 and female students had low in skill 7.

Research Question Three: What is the influence of school type on level of science process skills acquired by students in qualitative analysis?

Scores on level of science process acquired by chemistry students in qualitative analysis by school type.

No. of Male	No. of Female	No. of co-educational
school Students 10	school students 10	school students 40

S/N	Process Skills	No. of Items	$\bar{x}$	SD	Level	$\bar{x}$	SD	Level	$\bar{x}$	SD	Level
1.	Observation	6	2.89	0.61	High	2.88	0.38	High	2.75	0.30	**High**
2.	Experimenting	4	2.86	0.43	High	2.86	0.35	High	2.65	0.72	**High**
3.	Controlling Variables	5	2.84	1.57	High	3.02	0.39	High	2.87	0.54	**High**
4.	Measuring	2	2.82	0.45	High	2.46	0.63	Low	2.64	0.51	**High**
5.	Recording	4	2.46	0.89	Low	2.37	1.00	Low	2.37	0.96	**Low**
6.	Communication	3	2.50	0.85	High	2.30	0.85	Low	2.31	0.95	**Low**
7.	Inference	3	2.46	0.94	Low	2.49	0.85	Low	2.49	0.88	**Low**
	Overall Mean		**2.69**	**0.67**	**High**	**2.63**	**0.67**	**High**	**2.58**	**0.69**	**High**

Table 3 above reveals that male school students had high level of acquisition of science process skills followed by the female schools and co-educational schools. These can be deduced from their overall mean scores of 2.69, 2.63, and 2.58 respectively. However, hypothesis two was tested to see if this difference is significant. Male school students had low level of acquisition in skill 5 and 7. Female school students had low level of acquisition in skills 4, 5, 6 and 7. And co-educational school students had low level in 5,6 and 7. Male school students had high level of acquisition in skills 1, 2, 3, 4 and 6. The female school students had high level of acquisition in skills 1, 2 and 3. The co-educational students had high level of acquisition in skills 1, 2, 3 and 4. However, hypothesis two was tested to see if this difference is significant.

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Research Question Four: What is the influence of school location on level of science process skills acquired by students in qualitative analysis?

Table 4: Mean ($\bar{x}$) and standard deviation (SD) of clusters of qualitative analysis scores on level of science process skills acquired by urban and rural locations.

No. of urban students 30 No. of rural students 30

S/N	Process Skills	No. of Items	$\bar{x}u$	SDu	Level	$\bar{x}r$	SDr	Level
1.	Observation	6	3.18	0.40	High	2.50	0.62	**High**
2.	Experimenting	4	2.98	0.48	High	2.60	0.46	**High**
3.	Controlling variables	5	3.22	0.52	High	2.50	1.20	**High**
4.	Measuring	2	2.76	0.50	High	2.52	0.53	**High**
5.	Recording	4	2.60	0.93	High	2.20	0.61	**Low**
6.	Communication	3	2.63	0.88	High	2.21	0.52	**Low**
7.	Inference	3	2.56	0.86	High	2.40	0.99	**Low**
	Overall Mean		**2.87**	**0.65**	**High**	**2.42**	**0.70**	**Low**

Table 4 shows that students from urban location had high level of acquisition of the science process skills in qualitative analysis than those from rural location as can be deduced from the overall mean score of 2.87 when compared to 2.42 of the rural location. Urban location high level in all the seven skills. Rural location had low level of acquisition on skills 5, 6 and 7 with high level on skills 1, 2, 3 and 4. However, hypothesis three was tested to see if this difference is significant.

Hypothesis 1: There is no statistically significant difference between the mean scores of male and female on level of science process skills acquired by students in qualitative analysis.

Table 5: Z- test comparison of the mean scores of male and female chemistry students on the level of science process skills acquired in qualitative analysis.

Gender	N	Mean	SD	Z-cal	Z-critical	Decision
Male	30	2.71	0.66	0.84	1.96	**Accepted**
Female	**30**	**2.51**	**0.81**			

From table 5, Z calculated value in respect of gender for students mean process skills scores in qualitative analysis items is 0.84 while the Z-critical value at 0.05 level of significance is

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1.96. Thus, the Z-calculated value is less than the Z-critical value. The null hypothesis (HO_1) is therefore not rejected. To this effect the researchers concluded that there is no statistically significant influence of gender on students' level of acquisition of science process skills in qualitative analysis.

Hypothesis 2: There is no statistically significant difference in the mean scores of male, female and co- educational school students on level of science process skills acquired by students in qualitative analysis.

Table 6: ANOVA Result of mean process skills scores ($\bar{x}$) of male, female and co-educational school chemistry students in qualitative analysis.

Source of variable	Df	Sum of squares	Mean squares	F-cal	F-critical	Decision
Between group	2	7.196	3.598			**Accepted**
Within group	57	89.189	1.565	2.30	3.15	
Total	**59**	**96.385**	**5.163**			

From the table above, the calculated F-value is 2.30 while the critical value of F with 2 and 57 degrees of freedom at 0.05 level of significant is
3.15.Thus the calculated F-value of 2.30 is less than the F-critical value of 3.15. Consequently, the null hypothesis (HO_2) of no significant difference in the mean process skills scores of male, female and co-education students in qualitative analysis is not rejected.

Hypothesis 3: There is no statistically significant difference in the mean scores of urban and rural students on level of science process skills acquired by students in qualitative analysis.

Table 7: Z-test comparison of mean scores of urban and rural chemistry students on level of science process skills acquired in qualitative analysis

Gender	N	Mean	SD	Z-cal	Z-critical	Decision
Male	30	2.87	0.65	2.74	1.96	**Rejected**
Female	**30**	**2.42**	**0.68**			

From table 7, Z-calculated value in respect of school location for students mean process skills scores in qualitative analysis items is 2.74 while the Z-critical value at 0.05 level of significance is

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1.96. Thus, Z-calculated value is greater than the Z-critical value. The null hypothesis (HO3) is therefore rejected. This agrees with the result of the research question four table 4 on the influence of school location.

Discussion

In table 1, the results showed that the mean scores of recording communication and inference were below the level of acquisition of those skills. This finding is in agreement with some other research findings (Okinuga, Ojo&Yande, 2013&Ayodgu, 2015) which showed that the level of acquisition of science process skills by the students is low.

The result in table 2 showed that the male students had higher level of acquisition of the skills than the female counterparts. Further investigation on Z- test on table 5 revealed that the calculated Z-value due to level is less than Z-critical value in qualitative analysis items at 0.05 level of significance. To this effect, the researchers accepted the null hypothesis. Therefore, there is no statistically significant influence of gender on level of process skills acquired by chemistry students in qualitative analysis. This finding is in agreement with the views of Akinbobola and Afolabi (2012) and Muhammad (2014) who found that gender had no significant influences on science process skills acquisition. But this in contrary to Njoku and Jacks (2011) and Ugwuanyi (2015), found out that gender had significant effect on acquisition of process skills.

Table 3 showed that there are some differences in the overall mean process skills scores of male, female and co-educational school students. This revealed that school type influences qualitative analysis skills acquisition. The ANOVA result on table 6 revealed that the F-critical is more than the calculated value. To this effect, the researchers did not reject the null hypothesis. Therefore, the finding of the study showed that there is no statistically significant influence of school type on the level of science process skills acquired by the chemistry students in practical chemistry. Hence, the result agrees with Ugwu (2009) and Adigun (2010) who found that school type has no influence on qualitative analysis skills acquisitionItdisagrees with the views of Yusuf (2010)andJacks (2013) who found that there was significant influence of school type on students' acquisition of science process skills.

Table 4 reveled that urban students had higher level of acquisition of the skills than the rural in qualitative analysis. Further investigation on the Z- test on table 7 revealed that the calculated Z-value due to level is higher than Z-critical. To this effect, the researchers therefore, rejected the null hypothesis. Therefore, there is a statistically significant influence of school location on level of science process skills acquired by chemistry students in qualitative analysis. The finding is in line with the findings of Akinbobola (2008) and Yusuf (2010) who found significant difference between urban and rural schools. In

contrary, Adigun (2010) and Ezeudu& Obi (2013) who found no significant influence of school location on students acquisition of science process skills.

Conclusion

In conclusion, students had low level of acquisition of the skillsonrecording, communication and inference in qualitative analysis. There is no statistically significant difference between the mean scores of male and female on the level of science process skills acquired by chemistry students in qualitative analysis. There is no statistically significant difference in the mean scores of male, female and co- educational school students on the level of science process skills acquired by chemistry students in qualitative analysis. There is a statistically significant difference between mean scores of urban and rural students on the level of science process skills acquired by chemistry students in qualitative analysis.

Recommendations

In order to solve the problems of students' low level of acquisition of science process skills, the following recommendations were made. The government should put as a pre-condition a well–equipped science laboratory for approval of any secondary school in the country.There is need for retraining of science teachers on process skills to promote active learning in the science laboratory. Pedagogical inspectors, principals and school administrators should be strict on the maximum use of the science laboratory by science teachers. More qualified science teachers should be employed and evenly posted since they are in a better position to use the practical activities in promoting students' level of acquisition of skills in practical chemistry in every school.

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