EXTRAVERSION AND GENDER AS CORRELATES OF SCIENCE PROCESS
SKILLS ACQUISITION IN CHEMISTRY QUALITATIVE ANALYSIS

Anselem Abonyi UGWUANYI,
Department of chemistry, Federal College of Education, Abeokuta, Ogun,
State, Nigeria,
anselemabonyi@gmail.com

Florence Obiageli EZEUDU,
Department of Science Education, University of Nigeria Nsukka,
Enugu State, Nigeria.
florenceezeud.unn.edu.ng

Monisade Folasade ADERANTI.
Department of chemistry, Federal College of Education, Abeokuta,
Ogun, State, Nigeria,
monisadeaderanti@gmail.com

Abstract: *The study investigated extraversion and gender as correlates of science process skills acquisition in Chemistry qualitative analysis among senior secondary school students in Enugu State, Nigeria.   The study was guided by two research questions and two hypotheses. A correlational research   design was adopted for the study. The population of the study comprised 5,754 senior secondary   school three (SSIII) Chemistry students in 292 public secondary schools in Enugu State. A sample   size of 360 SSIII Chemistry students in 2021/2022 academic session drawn using multi-stage sampling procedure was used for the study. Students' extraversion inventory (SEI) and Chemistry   qualitative analysis skills rating scale (CQASRS) were the instruments used for data collection. The two instruments were face validated by five experts and construct validity was done on SEI using   factor analysis.   The reliability coefficient of SEI items was established using Cronbach Alpha   method as 0.85. The reliability estimate of CQASRS was established using Kendall`s Co-efficient of concordance (w) as 0.92. The research questions and hypotheses (tested at 0.05 level of significance) were answered using Correlation coefficients (r) of Pearson, ANOVA of linear regression and Hayes Process Analysis. Findings of the study revealed that the relationship between students' extraversion*

and their science process skills acquisition in chemistry qualitative analysis was moderate, positive and significant. The moderating influence of gender on the relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis was high, positive and not significant. Based on the findings of the study, it was recommended amongst others that, students should be encouraged to undergo self-assessment of their extraversion personality in the way they view and interpret Chemistry qualitative analysis.

Keyword*: Extraversion; Gender; science process skills (SPS); Chemistry*

Introduction

Through society's efforts in natural world to satisfy their needs, Chemistry had broadened their knowledge of methods of water purification and food preparation, varying materials for construction of industries, roads, automobile and home in addition to solving problems resulting from human interaction with the environment (Emendu, 2014). It exposes students to skills which enable them to perform experiments and learn to observe, record, calculate precisely and make intelligent inferences (McDonnel, 2017). Chemistry is an experimental science which relies primarily on the harmony between theory and practice and, therefore, should be taught as such. Understanding the concepts of practical Chemistry, therefore, will assist in enhancing students' understanding and acquisition of skills in Chemistry (Henry, 2017). This is in line with the objectives of senior secondary school Chemistry curriculum in Nigeria. The objectives of senior secondary school Chemistry curriculum include to help students to develop interest in the subject of Chemistry; enable students to acquire basic theoretical and practical knowledge and skills; help learners to acquire basic STM knowledge and skills; among others **(**FME, 2009, P. ii-iii**)**. These objectives could be achieved through practical Chemistry.

Practical Chemistry at the senior secondary school level consists of two major aspects namely quantitative analysis and qualitative analysis. Quantitative analysis is the estimation of quantity of substances such as acids, bases and salts (Ugwuanyi, 2015). Qualitative analysis deals with identification of various species (cations, anions and functional groups) present in a mixture of species without bothering on the quantity. It answers the question of what is present or not? It consists of the following: preliminary test; cation test and its confirmatory test (metal ions); anion test and its confirmatory test (acid radicals or anions); functional group test and test for starch, proteins, fats and oils.

According to Muhammad (2015), it is aimed at demonstrating proficiency in making reasonable, acceptable and accurate inferences from experimental observations. Qualitative analysis activities stimulate students and teachers' interest when properly carried out. It also, helps students to acquire basic Chemistry knowledge and skills needed to provide positive contributions to the global society through series of tests during practical activities. By this means, students can acquire various science process skills through a systematic series of tests being carried out.

 In spite of the valuable benefits of Chemistry qualitative analysis, students' achievement scores at senior secondary school level have been unsatisfactory. This situation has been reported by researchers such as Omiko (2015) and Banjoko, et al. (2018), who observed that students achieved poorly in secondary school science subjects especially Chemistry. Similarly, secondary school students' achievements in Chemistry in Nigeria as reported by the statistics section of West African Examination Council (WAEC) office (2017) from 2007 to 2016 fluctuated. In addition, analysis of reports from the Chief examiners' of WAEC, 2017-2021 showed that mean achievement scores of students in Chemistry practical fluctuated. The poor achievement of students in Chemistry in general, and qualitative analysis aspect of Chemistry paper 3 in particular, were attributed to some factors as reported by WAEC Chief Examiners. For instance, the WAEC Chief Examiner in these years commented on the strengths of the students in their ability to carry out tests and identify the gases evolved. But the factors that affected their poor achievement include inability to record observations, carrying out test on solid sample instead of solution, inability to identify colours and give logical inferences. The above weaknesses contributed to their low achievement in Chemistry qualitative analysis.

From the above reports, it could be deduced that the poor achievement in Chemistry qualitative analysis could be attributed to low Chemistry practical skills acquisition. These reports are in agreement with Ugwuanyi (2015), who revealed that students had low level of acquisition of science process skills (SPS) in Chemistry qualitative analysis in Enugu State. This unsatisfactory situation if not checked would have adverse effect on the students such as students' low interest and enrolment in Chemistry and society in general, such as shortage of manpower in professions like medicine, pharmacy and nursing amongst others. Considering the consistent poor achievement of students in Chemistry, researchers have investigated on different factors that have constituted to the ugly state apart from low level of acquisition of SPS as stated above. Other factors include class size and gender (Jack, 2018), classroom environment and interest (Ezike, 2018), extent of use of practical activities (Okorie & Ugwuanyi, 2019) amongst others. Despite

these efforts made by these researchers, the issue of poor academic achievement evidenced by poor acquisition of SPS among students still persists.

Science process skills are among the skills acquired during Chemistry practical activities. Aydogdu (2015) defined science process skills as mental and physical abilities and competencies which serve as basic tools required for the effective study of science and technology as well as problem solving for individual and societal development. These skills can be referred to as the 21st century skills that are needed in Science, Technology, and Engineering and Mathematics (STEM) subjects to improve the technological advances. The American Association for the Advancement of Science (AAAS, 1967) classified the science process skills into fifteen which consist of basic and integrated skills. The skills include; observing, measuring, classifying, communicating, predicting, inferring, using number, using space/time relationship, questioning, controlling variables, hypothesising, defining operationally, formulating models, designing experiment and interpreting data. The basic process skills are suitable set of skills introduced in science learning for primary school and junior secondary school levels and provide a foundation for learning the integrated skills. While the integrated process skills are more suitable for senior secondary and tertiary school levels (Seetee, et al. 2016). Hence, both basic and integrated science process skills are relevant and appropriate at the senior secondary school level in Nigeria. The acquisition of process skills by studying Chemistry as course enables students to understand the concepts of Chemistry easily, promote positive attitudes towards Chemistry among students. Despite the importance of science process skills, there is a serious educational gap in this area as evidenced by Jack (2018) both in bringing these skills into the classroom and in the training of teachers to use them effectively which results in low acquisition of the skills. Irwanto, et al. (2018) also revealed that low level of students' acquisition of SPS in terms of some variables in Chemistry, results to poor achievement in Chemistry. Researches into the factors that could cause students' low acquisition of science process skills attributed them to factors among which include personality (Ezike, 2017), gender (Jack, 2018), self-efficacy (Oyelekan, et al. 2019) amongst others.

The way people interact in a group varies greatly from one person to another. Some people are open and relaxed. They easily talk to others and enjoy social interaction and contributing in groups. Others are reserved and find it difficult to communicate in a group. Such individuals avoid contributing in social settings. These personality types are known as extraversion and introversion respectively (Ramyashilpa, 2020). Individual acquisition of science process skills in chemistry qualitative analysis may be greatly influenced by an individual's

personality type, hence, it is important to find out whether the extraversion aspect of personality and students' acquisition of science process skills are related. Personality refers to individual differences in the way they feel, think and behave that make individuals similar to and/or different from each other (Nyarko, et al. 2016). Though the dimensions of personality are beyond one's control, they strongly influence one's attitudes, expectations, assumptions and behaviour. John and Srivastava (1999) identified a popular and extensively used personality constructs model known as Five Factor Model (FFM) which extraversion is a facet of it. Extraversion refers to the ability of the students to be assertive, exciting, positive emotions, enthusiastic, engagement, action-oriented individuals and are often perceived as full of energy. Extroverts are outgoing and sociable, whereas introverts are more solitary and dislike being the centre of attention (Friedman & Schustack, 2016). According to researchers such as Chen and Lai (2015), Mkpanang (2015), Taiwo and Amadi (2019) that extraversion was positively and significantly correlated with achievement. The studies by Mahmuda (2017), Khan, et al. (2018) and Shaka (2020) revealed no significant correlation between extraversion and academic achievement among school students.

The extraversion of individuals may differ in males and females. In other words, gender may be a moderating variable on students' extraversion. According to Eyi (2019), gender is culturally and socially constructed roles, responsibilities, privileges, relations and expectations of women, men, boys and girls. The concept of gender in any society determines the existence of ways of life of the members in the society. Gender differences have historically been held responsible for divergence in academia and career success. The influence of gender on students' extraversion and their science process skills acquisition has continued to attract the attention of the educators and researchers. Some studies have been carried out to find out the influence of gender on students' extraversion or their science process skills acquisition. For instance, Zeidan and Jayosi (2015) and Khan (2020 reported that there was no significant difference on attitudes to science and extraversion on academic performance with regards to gender among students respectively. The studies by Kusnierz, et al. (2020) and Olowookere, et al. (2020) found significant difference on the effect of gender and students extraversion on educational performance. The above studies indicated that there are inconsistent results with respect to influence of gender on extraversion and acquisition of SPS. Therefore, the researchers deemed it important to contribute to the academic debate on influence of gender on extraversion and SPS acquisition due to contradictory results.

Statement of Problem
In spite of the valuable contributions of Chemistry to the society, Chemistry students' achievement at senior secondary school level has been unsatisfactory. This situation has been reported by researchers and WAEC Chief Examiners. The average percentages of students' achievements in Chemistry in Nigeria as reported by WAEC Chief Examiners from 2007 to 2021 revealed that achievement of students in Chemistry has been relatively low, fluctuating and unsatisfactory. The reports also showed that the students' poor achievement in Chemistry qualitative analysis contributed to their overall poor achievement in Chemistry. This is because students' achievement in qualitative analysis forms part of their overall assessment in Chemistry. This might have resulted from the students' poor acquisition of science process skills in Chemistry qualitative analysis.

The knowledge of process skills in science and chemistry in particular is very important for proper understanding of concepts, which allow students to conduct investigation and reach conclusions in chemistry qualitative analysis. In spite of these importance of science process skills, research reports have revealed students' low acquisition of skills which has become more evident in students' poor achievement in Chemistry. Researches have shown that the acquisition of science process skills could be affected by some factors such as; personality, gender and self-efficacy amongst others.

Available studies revealed that extraversion has been associated with academic motivation and achievement. From studies reviewed, there is no evidence to the best knowledge of the researchers whether students' extraversion relates to acquisition of SPS in Chemistry qualitative analysis or not. In addition, there are still conflicting results and inconclusiveness on the moderating influence of gender on students' extraversion or acquisition of science process skills. The problem of the study, put in form of a question therefore is: what is the relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis using gender as moderating variable?

Purpose of the study
In line with the problem of the study, the purpose of the study was to examine extraversion and gender as correlates of senior secondary school students' science process skills acquisition in Chemistry qualitative analysis in Enugu State. Specifically, the study intends to:
 1.   find out the relationship between students' extraversion and their science process skills acquisition   in Chemistry qualitative analysis.

2.   find out the moderating influence of gender on the relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis.

Research Questions
The following research questions guided the study
    1. What is relationship between students' extraversion and their science process skills acquisition in Chemistry qualitative analysis?
    2.   What is moderating influence of gender on the relationship between students' extraversion   and their acquisition of science process skills in Chemistry qualitative analysis?
Hypotheses
Based on the purpose of the study, the following null hypotheses were formulated and tested at 0.05 level of significance.
    1. There is no significant relationship between students' extraversion and their science process skills   acquisition   in   Chemistry qualitative analysis.
    2. There is no significant moderating influence of gender on the relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis

Methodology
The study adopted a correlational survey research design. The study was carried out in secondary schools in Enugu State, Nigeria The population of the study comprised 5,754 senior secondary school three (SSIII) Chemistry students in 292 public secondary schools in Enugu State. A sample size of 360 SSIII Chemistry students consisting of 184 males and 176 females, in 2021/2022 academic session from fifteen (15) schools drawn using multi-stage sampling procedure was used for the study. Students' extraversion inventory (SEI) adapted from (John and Srivastava, 1999) and Chemistry qualitative analysis skills rating scale (CQASRS) adapted from (Ugwu, 2014) were the instruments used for data collection. The SEI and CQASRS consisted of two sections –A and B. Section A dealt with personal information of the students such as students' identification number and gender. While section B of SEI contains items statements on students' extraversion facet of personality. The instrument contains both positive and negative statements. The scale is SA-4 points, A-3 points, D-2 points and SD-1 point for positive statements and vice versa for negative statements. Section B of CQASRS consisted of items statements of Chemistry qualitative analysis under the ten science process skills. The rating scale points are: Excellent (E) – 4 points, Good (G) - 3 points, Fair (F) - 2 points and Poor (P) - 1 point.
The two instruments were face validated by five experts and construct

validity was done on SEI using factor analysis. The reliability coefficient of SEI items was established using Cronbach Alpha method as 0.85. The reliability estimate of CQASRS was established using Kendall`s Co-efficient of concordance (w) as 0.92. After rating students on CQASRS by the researchers during the qualitative analysis activities and the administration of SEI to the students, the scores of the two instruments were converted to percentages to standardize them since the number of items in both instruments are not equal. The research questions and hypotheses (tested at 0.05 level of significance) were answered using Correlation coefficients (r) of Pearson, ANOVA of linear regression and Hayes Process Analysis. The degree of the relationship was interpreted in accordance with Okoye (2015) as follows: r = 0.00, no relationship, r = 0.00 to ± 0.20, very low relationship; r = ± 0.20 to ± 0.40, low relationship; r = ± 0.40 to ± 0.60, moderate relationship; r = ± 0.60 to ± 0.80, high relationship and r = ± 0.80 to ± 1.00, very high relationship.

Results

Research Question One: What is the relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis?

Table 1: Pearson's Product Moment Correlation Coefficient (r) and Coefficients of Determination (R^2) of the Relationship Between Students' Extraversion and their Acquisition of Science Process Skills in Chemistry Qualitative analysis.

Variables			N	$\bar{X}$	SD
r	R^2				
Students' extraversion			360	44.86	5.95
0.45	0.20				
Science process skills			360	55.67	8.68

KEY: N = Number of respondents, r = Correlation coefficient, R^2 = Coefficient of determination.

Result in Table 1 shows the relationship between students' extraversion and their acquisition of science process skills (SPS) in Chemistry qualitative analysis. The result indicates that the correlation coefficient (r) obtained between students' extraversion and their acquisition of SPS in chemistry qualitative analysis was 0.45. This shows that there is a moderate positive correlation between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis.

Hypothesis One: There is no significant relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis.

Table 2:   Regression ANOVA test of Significant Relationship Between Students' Extraversion and their Acquisition of Science Process Skills in Chemistry Qualitative Analysis

Model		Sum of Squares	df	Mean Square	F
Sig.	Dec				
	Regression	5524.192	1	5524.192	
91.901	.000^b S				
1	Residual	21519.472	358	60.110	
	Total	27043.664	359		

$\alpha = 0.05$, S = significant, NS = not significant

Result in Table 2 shows that an f-ratio of ($F(1, 359) = 91.901$, $p = 0.00$) was obtained for the relationship between students' extraversion and their acquisition of science process skills (SPS) in Chemistry qualitative analysis. Since the associated probability (p) value of 0.00 is less than 0.05 level of significance at which the result is being tested, the null hypothesis one ($H0_1$) which states that there is no significant relationship between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis is, therefore, not accepted. Hence, inference drawn is that, the relationship between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis is statistically significant. This implies that students' extraversion made a significant association with their acquisition of SPS in Chemistry qualitative analysis.

Research Question Two: What is moderating influence of gender on the relationship between students' extraversion and their science process skills acquisition in Chemistry qualitative analysis?

Table 3: Andrew Hayes Macro Process Analysis of the Moderating Influence of Gender on the Relationship Between Students' Extraversion and their Acquisition of Science Process Skills in Chemistry Qualitative Analysis.

Model	Interaction	N	r	R^2	SE
t	P	Dec			
1	Extraversion × gender	360	0.667	0.44	8.14
1.88	0.06	N			

The result in Table 3 shows the relationship between students' extraversion and the acquisition of science process skills (SPS) as moderated by gender. The result shows that the correlation coefficient (r) of 0.667 was obtained. This means that there is a high positive relationship between students' extraversion and acquisition of SPS as moderated by gender.

Hypothesis Two: There is no significant moderating influence of gender on the relationship between students' extraversion and their acquisition of science process skills in Chemistry qualitative analysis.

The result as shown in Table 3 on the significance different in the moderating influence of gender on the relationship between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis indicates that a t-value of 1.88 with associated probability value of 0.06 was obtained. Since the probability value of 0.06 is greater than 0.05 set as the level of significance, the null hypothesis seven ($H0_2$) which states that there is no significant difference in the moderating influence of gender on the relationship between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis is accepted. Inference drawn is that, the moderating influence of gender on the relationship between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis is not statistically significant.

Discussion

The findings of the study revealed that the relationship between students' extraversion and their acquisition of science process skills (SPS) in Chemistry qualitative analysis is moderate, positive and significant. This could be so since extraversion individuals are action-oriented. Hence, it could be reasonable to expect students who possess moderate level of extraversion to be active in Chemistry qualitative analysis activities which ultimately could lead to improve acquisition of SPS. It also implies that, there is proof that students who are outgoing and interacts with others, learn a lot in the course of their relationship, especially in the academic environment. Those who are introverts and less sociable have the tendency of missing the learning opportunities in social interactions. The finding is in agreement with Chen and Lai (2015), Mkpanang (2015), Taiwo and Amadi (2019) who found that extraversion was positively and significantly correlated with achievement. These findings indicate that, the level of education or class of a person may not influence the outcome of association between students' extraversion and their acquisitions of SPS. However, it disagreed with Mahmuda (2017), Khan, et al. (2018) and Shaka (2020) who found out that there was no significant correlation between extraversion and academic achievement among school students. The disparity between the present study and the previous studies could be because of differences in subject areas, quality of education of countries involved, domain of education objectives tested in the study which might have activated some differences in terms of concepts and exposures.

The analysis of research question two and the corresponding hypothesis two

revealed that there was a high, positive and significant moderating influence of gender on the relationship between students' extraversion and their acquisition of SPS in Chemistry qualitative analysis. This could be true since both male and female students were taught by same teacher in the same environment, hence, they are expected to posses the same attributes in the same phase. This implies that extraversion is personal and individualistic and not necessarily a product of person's gender, hence no significant difference. The finding is in accordance with Zeidan and Jayosi (2015) and Khan (2020) who reported that there was no significant difference on attitudes to science and extraversion on academic performance with regards to gender among students respectively. The relationship between the previous findings and the present study might have resulted from same personality facet, instrument used for data collection and influence of gender on science process skills with the same level of education. The finding is not in agreement with Kusnierz, et al. (2020) and Olowookere, et al. (2020) who found significant difference on the effect of gender and students' extraversion on educational performance. The disparity between the present study and the previous studies could be due to differences in level of education, sample size and quality of education between the countries.

Conclusions

Based on the findings and discussions of the study, the researchers concluded that students' extraversion positively and significantly associated with their acquisition of science process skills (SPS) in Chemistry qualitative analysis. This implies that students should be encouraged to avoid high level of extraversion which could impact negatively on their acquisition of SPS. In addition, the moderating influence of gender on the relationship between students' extraversion was positive but not significant correlate of their acquisition of SPS in qualitative analysis. The finding of this study dismisses the notion of gender disparity in students' extraversion and achievement in academic achievement or acquisition SPS in chemistry qualitative analysis.

Recommendations

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

1. Students should be encouraged to undergo self-assessment of their extraversion aspect of personality to avoid high level which could impact negatively on the way they view and interpret Chemistry qualitative analysis.
2. Chemistry teachers are expected to identify the extraversion facet of personality of students to render necessary academic help to avoid high level which   could   lead   to   low acquisition of skills in chemistry qualitative analysis.

3. The government through Post-Primary School Management Board (PPSMB) is expected to allocate necessary budget, arrange training, seminar and workshop on the issue of students' personality.

4. Parents should exhibit a set of emotional and behavioural patterns worthy of emulation to avoid high extraversion which would affect their acquisition of skills.

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