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Research Article

Relationships Between Students' Neuroticism and Gender on the Acquisition of Scientific Process Abilities in Chemistry Qualitative Analysis

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Abstract
Using qualitative analysis, the study examined the relationship between neuroticism and gender on the acquisition of chemistry process skills among Nigerian senior secondary school pupils in Enugu State. The investigation was based on two research questions and two hypotheses. A correlational survey research design was employed in the study. 292 public secondary schools with 5,754 SSIII Chemistry students made up the study's population. 360 SSIII students were included in the sample using a multistage sampling procedure. Data were gathered using the students' neuroticism inventory (SNI) and the chemistry qualitative analysis skills rating scale. Face validity was assessed by five experts, and factor analysis was used to determine construct validity for SNI. A reliability coefficient of 0.78 for SNI items was obtained by the Cronbach's alpha method. Kendall's coefficient of concordance (*w*) was used to calculate the reliability estimate of 0.92 for CQASRS. ANOVA of linear regression, Hayes Process Analysis, and Pearson's Correlation coefficient (*r*) were employed to examine the hypotheses and research questions (all tested at the 0.05 level). The growth of science process abilities and students' neuroticism were discovered to have a moderate, positive, and significant correlation in the Chemistry qualitative analysis. In the qualitative study on chemistry, gender had a significant, positive, and strong moderating effect on the connection between students' neuroticism and ability to acquire chemistry processes. Given the findings that there is a moderate and substantial association, students should be counseled to avoid excessive levels of neuroticism, since this could negatively impact their learning of scientific method abilities. Consequently, to reduce the gender disparity observed in this study, it was also recommended that chemistry instructors promote their students' engagement in qualitative analytical exercises.

Keywords: Chemistry, Gender, Neuroticism, Science Process Skills

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1. INTRODUCTION

Chemistry is important to society because it helps us comprehend the natural world and discover practical answers to current problems, thereby improving our quality of life. According to research, chemistry education has a positive correlation with real-world applications such as water purification technologies and analytical approaches for monitoring water quality, as well as food processing and material development, which benefit industry and transportation while promoting environmental sustainability. In chemistry classrooms, experimental and inquiry-based approaches assist students in developing fundamental scientific abilities like attentive observation, accurate measurement, systematic recording, and logical reasoning, all of which are required for scientific inquiry and problem resolution. Furthermore, empirical studies suggest that well-designed laboratory instruction significantly increases students' acquisition of science process and practical laboratory abilities, emphasizing the need to combine hands-on experience with conceptual teaching in effective chemistry education (Alkhadra et al., 2022; Efe & Abamba, 2023; Jegstad, 2023; Rosales-Conrado & Peña-Martínez, 2023).

The two main components of practical chemistry at the senior secondary level are usually quantitative and qualitative analysis, both of which are required for school certificate practical examinations (for example, volumetric determinations for acids, bases, and salts; and identification of ions, functional groups, or other chemical species in mixtures). According to studies in Nigeria and abroad, laboratory-based teaching techniques significantly improve students' development of science method abilities in chemistry practical is contrast to teaching that solely consists of lectures (Abbey-Kalio, 2024; Efe & Abamba, 2023). When practical work is properly organized and given adequate time, students demonstrate greater proficiency in observation, manipulation, measurement, recording, inference, and interpretation, all of which are necessary for accurate qualitative and quantitative reasoning in chemistry (Efe & Abamba, 2023). Qualitative analysis activities, such as preliminary tests, cation/anion tests, confirmatory tests, functional-group tests, and biomolecule tests (e.g., starch, proteins, lipids, oils), teach students how to identify what is in a combination. Quantitative tasks, on the other hand, require the estimation of substance quantities, which fosters precise math and measurement abilities. Because practical chemistry combines theory and hands-on experience, it is critical for developing deep conceptual understanding, enhancing laboratory competency, and preparing students for certificate-level chemistry exams and real-world chemical reasoning.

It also gives students the opportunity to obtain essential chemical knowledge and practical skills, preparing them to make significant contributions to society. Learners conduct hands-on investigations utilizing controlled laboratory assignments and sequential assessment activities, which foster the acquisition of crucial science-process abilities like observation, measurement, classification, reasoning, and interpretation. In this way, practical chemistry provides a methodical approach to helping students gain competence and confidence in scientific investigation.

Although practical chemistry is necessary for good chemistry instruction, many learners in their last year of senior secondary school still find this aspect of chemistry difficult. Recent empirical studies have shown that inadequate laboratory infrastructure, insufficient practical sessions, and poor instructional methods, rather than students' innate ability, frequently account for low chemistry achievement (Chikendu, 2022; Ramatu, 2025; Kazeem et al., 2023). These systemic and resource-related limits limit students' ability to complete practical activities correctly, record observations accurately, and make valid inferences, particularly in qualitative parts of chemistry. Students frequently struggle with correctly executing tests, interpreting reactions (e.g., colour changes, gas evolution), and writing logical conclusions in circumstances where practical work is limited or poorly structured. As a result, persistently poor performance in senior secondary chemistry, especially in practical components, is connected to institutional problems in practical chemistry delivery rather than individual learner deficiencies.

Available information indicates that low performance in qualitative chemistry, particularly in secondary schools, is frequently associated with insufficient learning of practical chemical abilities. Studies show that when students lack hands-on experience and guided practical instruction, their ability to perform qualitative analyses (such as identifying ions, interpreting reactions, and recording observations) suffers, contributing to poor chemistry exam performance (Efe & Abamba, 2023; Abbey Kalio, 2024; Musa et al., 2022). Even when other factors such as classroom environment, class size, and teaching techniques are taken into account, impairments in Science Process Skills (SPS) remain a consistent barrier to meaningful chemistry learning and consistent academic achievement (Oguche & Achimugu, 2025; Ronoh et al., 2022). If this gap in practical skill acquisition is not addressed, it may result in a decrease in student interest and enrolment in chemistry, as well as a decrease in the availability of skilled professionals in chemistry-intensive professions like medicine, pharmacy, and nursing.

Key competences acquired through chemistry lab work and other science learning activities are known as SPS. SPS are mental and physical skills that are essential for learning science and technology and for solving problems on a personal and societal level (Gizaw & Sorsa, 2023; Tijani, 2025). These talents are increasingly recognized as essential 21st-century skills in the STEM (science, technology, engineering, and mathematics) domains, encouraging technological advancement and scientific literacy. Modern reviews and empirical studies identify a set of SPS originally defined through the AAAS, or American Association for the Advancement of Science (1967), which includes observing, measuring, categorizing, communicating, predicting, inferring, utilizing numbers, comprehending relationships between place and time, asking questions, managing variables, formulating hypotheses, operational definition, modeling, creating experiments, and analyzing data.

Studies generally divide SPS into two hierarchical categories: fundamental SPS, which includes seeing, measuring, classifying, communicating, inferring, predicting, and employing numbers or space/time interactions, and integrated SPS, which includes more complex tasks such as operational definition, hypothesis formulation, variable control, experiment design, model construction, and data interpretation. Basic process skills are suitable for use as a starting point in primary and junior secondary science teaching. Senior secondary and postsecondary students gain more from integrated process skills, which are more complex and closely related to scientific inquiry practices (Chinda & Achigbe, 2024; Gizaw & Sorsa, 2023). Thus, both basic and integrated SPS remain relevant and acceptable for senior high school science instruction in Nigeria and abroad, as they support not just conceptual comprehension but also problem solving, scientific reasoning, and practical scientific literacy.

Chemistry coursework that includes hands-on practical work develops SPS, which helps students understand chemical topics and build more favorable attitudes toward chemistry (Abbey Kalio, 2024; Okafor, 2021). However, despite the widely acknowledged value of SPS for effective chemistry learning, many students continue to exhibit poor SPS acquisition, a shortcoming attributed in part to traditional pedagogies and insufficient practical exposure (Abbey Kalio, 2024). For example, laboratory-based teaching methodologies have been shown to significantly improve students' SPS acquisition when compared to lecture-based instruction.

In addition, studies show that learner traits such as personality and gender can influence SPS acquisition. A study of Nigerian secondary school chemistry students found a moderate, positive relationship between pupils' levels of extraversion and SPS acquisition; the authors also looked into how gender influences this relationship (Ugwuanyi et al., 2024). Furthermore, it has been demonstrated that using learner-centered or inquiry-based pedagogies—as opposed to exclusively teacher-centered approaches—is more successful in fostering SPS in children with a range of cognitive abilities, underscoring the significance of instructional design in SPS development. As a result, while SPS remain important for conceptual mastery and positive engagement with chemistry, current evidence suggests that their effective acquisition is heavily dependent on the teaching method, instructional environment, and individual learner characteristics, rather than simply enrolling in a chemistry class.

Because personality varies among individuals, it is vital to explore whether the "neuroticism" personality trait is related to students' development of SPS. Personality shows consistent individual characteristics in how people feel, think, and behave, which influence attitudes, motivation, and responses to learning circumstances. The widely used Big Five (FFM) framework includes neuroticism as a key feature. According to research, higher levels of neuroticism can result in decreased academic motivation and performance (Apostolov & Geldenhuys, 2022; Meyer et al., 2023). In science education, when mastering SPS demands careful observation, emotional stability, perseverance under pressure, and continuous focus during experiments, students who score highly on neuroticism may be more susceptible to stress, anxiety, and emotional instability. These emotional tendencies may hamper their ability to concentrate during experiments, endure through tough tasks, or maintain the calm essential for effective scientific reasoning. Students with reduced neuroticism (i.e., stronger emotional stability) may be better able to manage academic stress, retain stability during complex lab work, and so build and use SPS efficiently. Individual personality variations, particularly neuroticism, may have a significant impact on how successfully students acquire and apply science process abilities in chemistry or other science fields.

Students in chemistry education, particularly in qualitative analysis, must develop not just a factual understanding of chemical reactions, but also procedural competence, critical thinking, and practical laboratory skills (Abbey Kalio, 2024; Okafor, 2021). Individual variables, such as neuroticism and gender, may influence students' ability to learn and use science process abilities. Neuroticism can manifest differently in men and women, hinting that gender may play a moderating role in its impact on learning outcomes (Lunardon et al., 2022). Gender is widely understood in contemporary scholarship as a socially constructed concept shaped by cultural norms, social interactions, and institutional expectations, which influence identity formation and participation in educational contexts (Jacobs & George, 2023). Gender research in STEM education has produced conflicting results: while some studies show that male and female students perform similarly when given equal learning opportunities, others show persistent disparities in participation, confidence, and achievement in science-related tasks (Lunardon et al., 2022; Verdugo-Castro et al., 2023). These findings imply that personality and gender are crucial factors in interpreting disparities in students' acquisition and application of SPS in chemistry, particularly in hands-on, inquiry-based laboratory settings where cognitive, emotional, and procedural abilities interact.

Researchers and educators are still interested in how gender affects students' neuroticism and the development of scientific process abilities. The impact of male and female students on their neuroticism and/or learning of scientific method abilities has been reported by several studies. Shaka (2020), Kusnierzeta et al. (2020), and Olowookere et al. (2020) are a few examples of studies that found gender differences in neuroticism trait and academic success, motivation measures, and performance, all of which favoured females. Khan (2020) discovered that gender had no significant effect on pupils' neuroticism. Gender does not significantly affect the development of science process skills, according to Ugwuanyi and Nwafor (2021). Jack (2018) found that chemistry students' development of science process skills was unaffected by gender or class size. Zeidan and Jayosi (2015), on the other hand, found a significant gender-based difference in science process skills that favoured females. Previous studies yielded different findings about the impact of gender on neuroticism and SPS acquisition.

According to the studies analysed, there is no evidence to suggest that students' neuroticism is related to the acquisition of SPS in chemical qualitative analysis. Furthermore, conflicting data and inconclusiveness remain regarding the moderating effect of gender on students' neuroticism or SPS development. Thus, gaps in SPS acquisition among chemistry students, their neuroticism personality trait, and gender warranted the current study. The study's problem, expressed as a question, is as follows: What is the connection between students' neuroticism and the development of scientific process abilities in chemistry in Enugu State, Nigeria, as evaluated by qualitative analysis with gender acting as a moderator?

1.1. Purpose of the Study

The study's objective was to investigate the association between neuroticism and gender on the development of chemistry process skills among senior secondary school students in Enugu State using qualitative analysis, in line with the theme. The research specifically aims to determine the:

1. correlation between the development of chemistry process skills in qualitative analysis and students' neuroticism.
2. association between students' neuroticism and their acquisition of chemistry process skills in qualitative analysis, as mediated by male and female students.

1.2. Research Questions

These research questions guided the research because they were pertinent to its purposes.

1. What association does neuroticism have with students' learning of chemical process abilities using qualitative analysis?
2. What is the mediating influence of males and females on their neuroticism and chemistry process abilities in qualitative analysis?

1.3. Hypotheses

The study's objectives led to the development and testing of the following null hypotheses at the significance level of 0.05.

1. The acquisition of scientific process skills in qualitative chemical analysis is not significantly correlated with students' neuroticism.
2. The association between students' neuroticism and the development of chemistry method abilities in qualitative analysis is not significantly moderated by gender.

2. METHODS

2.1. Research Design

In this study, a correlational survey research design was used. According to Bhandari (2023), a correlational survey research methodology is a non-experimental method for figuring out how two or more variables relate to one another without changing them. It often indicates the direction and size of the association between the factors under investigation. The research was conducted in six educational zones of Enugu State, Nigeria. There are varying numbers of public senior secondary schools in each of the six Education Zones: Agbani Zone (44), Nsukka Zone (59), Obollo-Afor Zone (49), Awgu Zone (55), Enugu Zone (31), and Udi Zone (54).

2.2. Participants

The study's population included 5,754 Chemistry students in senior secondary three (SSIII), including 2,751 men and 3003 females from 292 public secondary schools across Enugu's six Education Zones. During the 2024/2025 academic year, 360 SSIII Chemistry students (184 males and 176 females) were selected from fifteen (15) schools in Enugu State, Nigeria, using a multi-stage sampling technique. The first stage involved selecting three (3) Education Zones from Enugu State's six through simple random sampling and balloting without replacement. In the second step, two (2) Simple random selections of two local government areas from each of the three Education Zones were made via balloting without replacement, for a total of six local governments. The third step involved fifteen (15) co-educational schools selected through purposive sampling. A proportionate stratified random selection process was employed in the fourth stage to determine the number of SSIII Chemistry students as well as male and female participants. The total number of SSIII Chemistry students at the fifteen (15) schools, including both male and female students, was utilized to establish how many students were sampled from each.

2.3. Research Instruments

John and Srivastava (1999) established the Students' Neuroticism Inventory (SNI), and the Chemistry Qualitative Analysis Skills Rating Scale (CQASRS) was revised by Ugwu (2014). SNI and CQASRS were separated into Sections A and B. The students' personal information, including their gender and ID numbers, was covered in Section A. The SNI's Section B contains item statements regarding the neuroticism component of students' personalities. The tool offers both favourable and negative item statements. Positive items were scored on a four-point Likert scale via: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1, while it is flipped for negative items. Section B of the CQASRS included Chemistry qualitative analysis item statements as one of the 10 science process skills. Excellent (E) receives four points, Good (G) receives three, Fair (F) receives two, and Poor (P) receives one. Five experts confirmed the two measures. Construct validity of SNI was examined using Principal component factor analysis. Cronbach's Alpha indicated a reliability rating of 0.78 for SNI items. CQASRS dependability was estimated using Kendall's Coefficient of Concordance (w) = 0.92.

2.4. Procedures

This study's data were obtained using the students' neuroticism inventory and the Chemistry qualitative analysis skills rating scale. Researchers visited the sampling schools to obtain clearance from the principals and SSIII Chemistry instructors to determine the most convenient date and time for the activities in their particular schools. This was completed in seven days. The researchers supplied the Chemistry teachers with a list of the requirements for carrying out the Chemistry qualitative analysis activities. The researchers taught research assistants (chemistry teachers) from the studied schools how to rate qualitative analysis items using CQASRS and the rating guide. Prior to the Chemistry qualitative analysis exercises, each school's Chemistry teacher assigned students an identity number. The students participated in Chemistry qualitative analysis exercises, which were subsequently graded on-the-spot by the researchers with the assistance of each school's research assistant/chemistry instructor in one and a half hours. The researchers then collected the students' answer sheets and marked the skills that could not be witnessed directly during the exercises, such as reporting, communication, inference, interpretation, and prediction. The researchers administered the SNI immediately following the qualitative analysis activities and gathered the results on the spot in 30 minutes.

2.5. Data Analysis

After the researchers graded students on CQASRS during the qualitative analysis activities and administered SNI to the students, because the two instruments had different numbers of items, the results were converted to percentages in order to standardize them. Version 23.0 of SPSS, the statistical software for social sciences, and Andrew Hayes Process version 4.0 were used to compute data analyses. The study questions and hypotheses were addressed using Hayes Process Analysis, ANOVA for linear regression, and Pearson's correlation coefficients (*r*) (at a significance level of 0.05). The degree of the association (*r*) as defined by Papageorgiou (2022) follows: < 0.20 = very weak relationship, 0.20–0.39 = weak relationship, 0.40–0.59 = moderate relationship, 0.60–0.79 = strong relationship, and ≥ 0.80 = very strong association.

3. RESULTS

The results are presented in accordance with the study's guiding research questions and null hypotheses.

Research Question One: What association does neuroticism have with students' learning of chemical process abilities using qualitative analysis?

Table 1 shows Pearson's product-moment correlation.

Table 1. Coefficient (*r*) Between Students' Neuroticism and Their Ability to Acquire a Qualitative Chemical Analysis

Factors	Number of Respondents	Mean	Standard Deviation	Correlation
Learner's neuroticism	360	57.88	9.78	0.47
Scientific Method abilities	360	55.67	8.68	

Table 1 illustrates the connection between students' neuroticism and the development of their scientific process abilities in qualitative analysis of chemistry. The study found that students' neuroticism and development of scientific method skills in qualitative analysis of chemistry have a 0.47 correlation coefficient (r). This indicates a somewhat favourable correlation between students' neuroticism and the growth of scientific process skills in qualitative analysis of chemistry.

Hypothesis One ($H0_1$): The acquisition of scientific process skills in qualitative chemical analysis is not significantly correlated with students' neuroticism.

Table 2. Correlation Between Students' Neuroticism and Their Ability to Acquire Science Process Skills in Chemistry Qualitative Analysis using Regression ANOVA

	Model	SS	Df	MS	F	Sig.	Decision
1	Regression	1408.204	1	1408.204	19.666	$.00^{b}$	Significant
	Residual	25635.460	358	71.607			
	Total	27043.664	359				

SS = Sum of squares, MS = Mean squares

The association between students' neuroticism and the development of SPS in chemistry was found to have an F-ratio (F (1, 359) = 19.666, p = 0.00) in Table 2. Since the associated probability (*p*) value of 0.00 is less than the 0.05 level of significance used to test the outcome, null hypothesis one (H01), which claims that there is no significant correlation between students' neuroticism and acquisition of SPS in chemistry qualitative analysis, is rejected. As a result, the study finds a link between students' neuroticism and their acquisition of SPS in chemical qualitative analysis. This suggests that students' neuroticism had an effect on their acquisition of SPS in chemistry qualitative analysis.

Research Question Two: What is the mediating influence of males and females on their neuroticism and chemistry process abilities in qualitative analysis?

Table 3. Andrew Hayes' Macro-Process Examination of How Gender Impacts the Relationship Between Students' Neuroticism and the Acquisition of Science Process Abilities in Chemistry Qualitative Analysis

Model	Interaction	N	R	SE	T	Sig.	Decision
1	Neuroticism × Gender	360	0.62	7.07	7.41	0.00	Significant

The connection between students' neuroticism and the growth of scientific process skills, which varies by gender, is shown in Table 3. The findings show that a correlation coefficient (*r*) of 0.62 was attained. It implies that students' neuroticism and the development of SPS, which differ by gender, are strongly positively correlated.

Hypothesis Two ($H0_2$): Gender does not significantly moderate students' neuroticism and science process learning skills in the Chemistry qualitative study.

Table 3 shows a statistically significant variation in the moderating influence of gender on the relationship between students' neuroticism and their acquisition of SPS in chemistry qualitative analysis, with a *t*-value of 7.41 and a probability value of 0.00. The second null hypothesis (H02), which asserts that gender significantly moderates the relationship between students' neuroticism and their acquisition of SPS in qualitative analysis of chemistry, is rejected because the probability value of 0.00 is below the significance level of 0.05. The study found that the link between students' neuroticism and their acquisition of SPS in qualitative analysis of chemistry is significantly moderated by gender.

4. DISCUSSION

The results of research question one and hypothesis one demonstrated a moderate, positive, and substantial association between students' neuroticism and the development of scientific method abilities using chemical qualitative analysis. This could be because kids with a high level of neuroticism experience a lot of anxiety. As a result, phobias may drive them to dislike and disengage from a variety of tasks. Students with moderate to low neuroticism, on the other hand, are motivated to maintain their focus. This could result in a moderate link between neuroticism and the acquisition of scientific process abilities. The present study's findings are consistent with Khan et al. (2018), who found a low but significant association between neuroticism and learning style in predicting academic achievement among school pupils. Similarly, the findings are consistent with those of Shaka (2020), who found a substantial link between pupils' neuroticism and academic achievement. However, the findings contradict Apostolov and Geldenhuys (2022), who reported that neuroticism shows weak or inconsistent associations with academic outcomes. The findings did not corroborate Mahmuda's (2017) finding that there was no significant association between neuroticism and English achievement.

The findings of the second research question and hypothesis showed that gender had a strong, positive, and substantial moderating effect of neuroticism on students' learning science process abilities through qualitative analysis in Chemistry. This could be due to the fact that reviewed studies found that male pupils outperform female students in science activities. Students with high levels of neuroticism experience high levels of anxiety. As a result, female students might have hated and disengaged from various practical activities due to their anxiety, resulting in a considerable disparity. The findings are consistent with the results of Kusnierzeta et al. (2020) and Olowookere et al. (2020), who discovered substantial gender differences in students' neuroticism trait, academic motivation measures, and performance in favour of females. It is consistent with Sander and Fuente's (2020) finding that gender had a statistically significant impact on the relationship between neuroticism and academic confidence among university students in Spain. Furthermore, the current study's findings are consistent with Akani's (2015) finding that gender had a substantial difference in the possession of skills by final-year Nigerian Certificate in Education (NCE) students in Nigeria's south-east states, which is disproportionately male. In contrast, the current study's findings contradict Khan (2020), who discovered that there was no significant change in the influence of neuroticism on academic performance by gender among Mumbai graduate students. Similarly, the study's findings differ from those of Ugwuanyi and Nwafor (2021), who discovered that gender and school type had no significant effect on Senior high school Chemistry students in Nigeria's Enugu Educational Zone, who demonstrated their science process skills in a qualitative assessment.

5. CONCLUSION

According to the researchers' best understanding of the papers they looked at, there was no proof that students' neuroticism and the growth of chemistry process abilities in qualitative analysis were correlated. Additionally, the influence of male and female students' neuroticism on scientific method learning abilities is ambiguous and produces conflicting findings. These deficiencies led to the problem of the study, which was articulated as the following question: Using a qualitative study with gender as a moderator in Enugu State, Nigeria, what connection exists between neuroticism and the growth of chemistry process abilities of students? Based on the results and comments, the investigators came to the conclusion that students' learning of scientific method abilities in the qualitative analysis aspect of Chemistry was positively and significantly connected with their neuroticism. This means that students should try to identify their learning strengths and limitations in Chemistry qualitative analysis in order to improve their Chemistry performance. Furthermore, in qualitative analysis, gender was found to be a positive and significant moderator of the link between students' neuroticism and their development of scientific process abilities. The outcomes of this study confirm the premise that there is a gender discrepancy in students' neuroticism and academic achievement, as well as the development of science process abilities through qualitative analysis in Chemistry.

Conclusions drawn from the study, however, are subject to the following limitation: (1) the study was a correlational analysis, and hence a causative pathway could not be determined. In other words, the study was unable to demonstrate a cause-and-effect link between students' neuroticism and their development of scientific process skills. As a result, regardless of the strength of correlation, it is impossible to conclude that one variable causes a change in another.

According to the findings, the investigators suggest that: (1) Students should enhance their neuroticism in order to close the gap in low skill acquisition in chemistry and become successful learners. (2) Chemistry teachers are expected to recognize students' levels of neuroticism in order to provide the appropriate academic support to avoid high levels, which could result in poor learning abilities in chemical qualitative analysis. (3) The stakeholders in education should provide required funds as well as training, seminars, and workshops on student individuality. (4) Chemistry teachers could provide appropriate incentives to both genders in their classes in order to encourage participation in qualitative analytical activities and close the gender gap reported in this study.

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Research Ethics. All necessary consent and permission were obtained from the school authorities before the commencement of the research. The study received ethical approval (REC/DSE/UNN/24/0072) from the Ethics Committee of the Department of Science Education at the University of Nigeria, Nsukka, Nigeria.

Data Availability Statement. All data can be obtained from the corresponding author.

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REFERENCES

Abbey-Kalio, I. (2024). Use of laboratory-based pedagogies on students' acquisition of science process skills in chemistry. *Direct Research Journal of Chemistry and Material Science, 12*(2), 20-26. https://journals.directresearchpublisher.org/index.php/drjcm/article/view/355

Akani, O. (2015). Levels of possession of science process skills by final year students of colleges of education in South-Eastern States of Nigeria. *Journal of Education and Practice, 6*(27), 94-101. https://files.eric.ed.gov/fulltext/EJ1077402.pdf

Alkhadra, M. A., Su, X., Suss, M. E., Tian, H., Guyes, E. N., Shocron, A. N., Conforti, K. M., de Souza, J. P., Kim, N., Tedesco, M., Khoiruddin, K., Wenten, I. G., Santiago, J. G., Hatton, T. A., & Bazant, M. Z. (2022). Electrochemical methods for water purification, ion separations, and energy conversion. *Chemical Reviews, 122*(16), 13547–13635. https://doi.org/10.1021/acs.chemrev.1c00396

American Association for the Advancement of Science. (1967). *Science-A process approach*. Xerox Corporation. https://www.aaas.org/archives/science-process-approach

Apostolov, N., & Geldenhuys, M. (2022). The role of neuroticism and conscientious facets in academic motivation. *Brain and Behavior, 12*(8), e2673. https://doi.org/10.1002/brb3.2673

Bhandari, P. (2023). *Correlational research: When & how to use*. Scribbr. Retrieved from https://www.scribbr.com/methodology/correlational-research

Chikendu, R. E. (2022). Factors affecting chemistry students' academic performance in senior secondary schools in Onitsha South Local Government Area, Anambra State, Nigeria. *International Journal of Research in Education and Sustainable Development, 2*(3), 23–31. https://www.ijaar.org/articles/ijresd/v2n3/ijresd-v2n3-Mar22-p2311.pdf

Chinda, W., & Achigbe, J. O. (2024). Science process skills and academic performance of students in Cross River State Colleges. *Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education, 6*(1), 126–132. https://www.fnasjournals.com/index.php/FNAS-JMSE/article/view/582

Efe, A. H., & Abamba, E. I. (2023). Effects of laboratory method on students' acquisition of science process skills in senior secondary school chemistry in Delta State, Nigeria. *European Journal of Education Studies, 10*(11), 284–296. https://doi.org/10.46827/ejes.v10i11.5078

Gizaw, G. G., & Sorsa, S. S. (2023). Improving science process skills of students: A review of literature. *International Journal of Science Education, 34*(3), 216–224. https://doi.org/10.33828/sei.v34.i3.5

Jack, G. U. (2018). Chemistry students' science process skills acquisition: Influence of gender and class size. *Global Research in Higher Education, 1*(1), 80–97. https://doi.org/10.22158/grhe.v1n1p80

Jacobs, T., & George, A. S. (2023). How gender is socially constructed in policy making processes: A case study of the adolescent and youth health policy in South Africa. *International Journal for Equity in Health, 22*(36). https://doi.org/10.1186/s12939-022-01819

Jegstad, K. M. (2023). Inquiry-based chemistry education: A systematic review. *Studies in Science Education, 60*(1), 1–63. https://doi.org/10.1080/03057267.2023.2248436

John, O., & Srivastava, S. (1999). The big five traits taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 102–138). Guilford Press. https://psycnet.apa.org/record/1999-04371-004

Kazeem, S., Gagdi, J. A., Muhammad, S. I., & Rabiu, A. (2023). Impact of chemistry practical activities on secondary school students' academic performance and achievement in Bauchi Metropolis, Nigeria. *ATBU Journal of Science, Technology and Education, 11*(2), 65–71. https://www.atbuftejoste.com.ng/index.php/joste/article/view/1789

Khan, A., Pyh Shin, L., Hishan, S. S., Mustaffa, M. S., Madihie, A., & Sabil, S. (2018). Effect of personality traits and learning styles towards students' academic achievement in Johor Bahru. *International Journal of Engineering and Technology, 7*(2.10), 4–9. https://doi.org/10.14419/ijet.v7i2.10.10943

Khan, D. (2020). Gender differences in personality traits in relation to academic performance. *MIER Journal of Educational Studies Trends and Practices, 10*(1), 124–137. https://doi.org/10.52634/mier/2020/v10/i1/1356

Kuśnierz, C., Rogowska, A. M., & Pavlova, I. (2020). Examining gender differences, personality traits, academic performance, and motivation in Ukrainian and Polish students of physical education: a cross-cultural study. *International Journal of Environmental Research and Public Health, 17*(16), 5729. https://doi.org/10.3390/ijerph17165729

Lunardon, M., Cerni, T., & Rumiati, R. I. (2022). Numeracy gender gap in STEM higher education: The role of neuroticism and math anxiety. *Frontiers in Psychology, 13*, 856405. https://doi.org/10.3389/fpsyg.2022.856405

Mahamuda, Y. (2017). *The correlation between personality constructs and English achievement of the eleventh-grade students in Palembang, Indonesia* (Unpublished master's thesis, State Islamic University Raden Fatah Palembang). https://repository.radenfatah.ac.id/13154/

Meyer, J., Jansen, T., Hübner, N., & Lüdtke, O. (2023). Disentangling the association between the Big Five personality traits and student achievement: Meta-analytic evidence on the role of domain specificity and achievement measures. *Educational Psychology Review, 35*, Article 12. https://doi.org/10.1007/s10648-023-09736-2

Musa, W. O., Akuba, J. C., & Gloria, S. A. (2022). Evaluating the impact of chemistry practical on students' performance in chemistry in public secondary schools of Nasarawa State, Nigeria. *International Journal of Research and Innovation in Social Science, 6*(12), 139–142.https://doi.org/10.47772/IJRISS.2022.61201

Oguche, G. O., & Achimugu, L. (2025). Effect of laboratory activity teaching method on students' interest and academic achievement in chemistry in Ikom Education Zone, Cross River State, Nigeria. *International Journal of Research and Innovation in Social Science, 9*(8), 5153-5161. https://doi.org/10.47772/IJRISS.2025.90800119

Okafor, N. P. (2021). Enhancing science process skills acquisition in chemistry among secondary school students through context-based learning. *International Journal of Science Education, 32*(4), 323–330. https://doi.org/10.33828/sei.v32.i4.7

Olowookere, E., Onamonjo, D., Oukoya, J., & Anyaegbunam, M. (2020). Exploring the effect of gender and personality characteristics on educational performance. *Journal of Educational and Social Research, 10*(5), 99–107. https://doi.org/10.36941/jesr-2020-0091

Papageorgiou, S. N. (2022). On correlation coefficients and their interpretation. *Journal of Orthodontics, 49*(3), 359–361. https://doi.org/10.1177/14653125221076142

Ramatu, U. (2025). Effect of experiential learning approach on retention and academic performance in chemistry among senior secondary school students in Kaduna Metropolis. *Journal of Educational Studies, Trends and Practice, 10*(8), 60–69. https://doi.org/10.70382/sjestp.v10i8.065

Ronoh, O. C., Waswa, P., & Lusweti, J. K. (2022). Effect of scientific competencies in chemistry practical on performance in chemistry subject. *African Journal of Education, Science and Technology, 6*(2), 206–216. https://medalhospital.world/index.php/ajest/article/view/511

Rosales-Conrado, N., & Peña-Martínez, J. (2023). Adding sustainability in analytical chemistry education through monitoring aquarium water quality. *Sustainable Chemistry, 4*(3), 282-303. https://doi.org/10.3390/suschem4030021

Sander, P. (2019). Undergraduate student gender, personality and academic confidence. *International Journal of Environmental Research and Public Health, 17*(15), 5567. https://doi.org/10.3390/ijerph17155567

Shaka, G. (2020). The relationship between students' personality types and their academic achievement in Oromia colleges of teachers' education. *International Journal of Psychological and Brain Science, 5*(3), 47–55. https://doi.org/10.11648/j.ijpbs.20200503.12

Tijani, B. E. (2025). Beyond memorisation: Investigating the influence of open inquiry on chemistry students' scientific process skills. *Journal of Research in Environmental and Science Education, 2*(2), 154–164. https://doi.org/10.70232/jrese.v2i2.23

Ugwu, A. (2014). Factorial validation of instrument for assessment of practical chemistry skills acquisition. *Journal of Education and Practice, 5*(8), 175–185. https://www.iiste.org/Journals/index.php/JEP/article/view/11654

Ugwuanyi, A. A., & Nwafor, S. C. (2021). Science process skills acquired by senior secondary school chemistry students in qualitative analysis in Enugu Education Zone, Nigeria. *Unizik Journal of Educational Research and Policy Studies, 7*(1), 518–533. https://unijerps.org/index.php/unijerps/article/view/174

Ugwuanyi, A. A., Ezeudu, F. O., & Aderanti, M. F. (2024). Extraversion and gender as correlates of science process skills acquisition in chemistry qualitative analysis. *Journal Plus Education, 36*(2), 384-397. https://doi.org/10.24250/jpe/2/2024/AAU/FOE/MFA/

Verdugo-Castro, S., Sánchez-Gómez, M. C., & García-Holgado, A. (2023). Factors associated with the gender gap in the STEM sector: Comparison of theoretical and empirical concept maps and qualitative SWOT analysis. *Heliyon, 9*(6), Article e17499. https://doi.org/10.1016/j.heliyon.2023.e17499

Zeidan, A. H., & Jayosi, M. R. (2015). Science process skills and attitudes towards science among Palestinian secondary school students. *World Journal of Education, 5*(1), 13–24. https://doi.org/10.5430/wje.v5n1p13