

Analyzing Weaknesses in Qualitative Chemistry Analysis: A Study of Senior Secondary School Students in Shendam, Plateau State, Nigeria

Dalla Charles Long'an & Dalaham, Philibus.Duhunkyes.

Longancd49@gmail.com

Abstract

The study examined common errors committed by senior secondary school students in qualitative analysis during chemistry practical in Plateau State. The study adopted a descriptive research survey design. One hundred students were randomly sampled from a population of one thousand two hundred and thirty-four students for the study. One instrument, the Pre-determined Common Errors Committed by Chemistry Students in Qualitative Analysis (PCECCSQA), was used to gather data from the respondents. The internal consistency of the (PCECCSQA) was determined using Kuder Richardson K-20 formula which yielded a reliability coefficient of 0.78. Data collected were analyzed using mean, frequency and percentage count. The result of the findings revealed that chemistry students committed common errors such as reporting, confirmatory test, identifications of gases among others. The study concluded that poor reporting and students' inability to identify gases released during qualitative chemistry practical are major reasons for underachievement in chemistry. The study recommended that chemistry teachers should be more concerned about students' practical report and encourage them to develop more sense of smelling during qualitative analysis.

Keywords; Chemistry, Chemistry Practical, Qualitative Analysis.

Introduction

Chemistry, as one of the core science subjects in Nigeria's senior secondary schools, plays a pivotal role in shaping students' scientific knowledge and practical skills. It is concerned with the study of matter, its properties, and the interactions that occur between various substances (Kumar et al., 2016). The practical aspect of chemistry, particularly qualitative analysis, is crucial for reinforcing theoretical concepts, fostering critical thinking, and nurturing essential scientific skills such as observation, identification, and analysis. As an inherently practical discipline, chemistry offers students the opportunity to engage directly with the materials and processes that constitute its study (Ayodele, 1999). However, despite its significance, many students in Nigerian secondary schools face substantial challenges in performing well in chemistry practicals, particularly in qualitative analysis, which often leads to poor academic outcomes and diminished interest in the subject.

Qualitative analysis in chemistry involves determining the composition of substances by identifying the presence of specific ions, gases, or elements without reference to their quantity. It is a skill-intensive aspect of the curriculum, requiring keen observation, the ability to conduct confirmatory tests, and a strong grasp of scientific procedures. However, students often struggle with this aspect of chemistry due to various factors, including inadequate resources, ineffective

teaching methods, and limited exposure to practical work (Ezeliora, 1997; Olayemi, 2000; Nwosu, 2000 & Jimoh, 2001; Cox, 2019). These challenges, coupled with the complex nature of qualitative analysis, result in frequent errors during practical sessions, which in turn, impact students' performance in external examinations such as WAEC, NECO, and NABTEB ((Osuide, 1998; Osaki, 2007).

The underperformance of students in chemistry, particularly in qualitative analysis, has been a subject of concern for educators and researchers alike (Otor, 2014). Several studies have identified a range of factors contributing to poor performance, including insufficient laboratory equipment, large class sizes, and ineffective teaching method (Eddy, 2000). Despite these efforts to investigate the broader issues surrounding chemistry education, little attention has been paid to identifying and addressing the specific errors that students make during qualitative analysis (Uchegbu, et al., 2016). This study aims to fill this gap by examining the common errors committed by senior secondary school students during qualitative analysis practicals in Plateau State, Nigeria.

The purpose of this research is to systematically identify the errors commonly made by students during qualitative analysis, assess their impact on students' performance, and suggest strategies for improvement. By highlighting these errors, this study hopes to offer insights into how the teaching and learning of qualitative analysis can be enhanced, ultimately improving students' performance in chemistry practicals and fostering a deeper understanding of the subject. Through this examination, the study contributes to the broader discourse on the challenges facing science education in Nigeria, offering practical recommendations for improving the quality of chemistry education at the senior secondary school level.

Statement of Problem

It is obvious that no nation can develop scientifically and technologically if her citizenry are not properly guided. The Nigerian education system is more certificate centered and therefore, skills acquisition is not properly taken care of with more emphasis placed on certification not minding the source. Qualitative analysis in chemistry is an aspect of chemical analysis that emphasized skills (process skills) of observations, smelling, identification, critical thinking, analytical skills among others which are some of the necessary skills require by secondary schools' students before graduation. However, this important aspect of chemistry is impeded by several factors ranging from students' factor to teachers' factor. During qualitative analysis, students commit several errors that could be avoided if identified early enough to improve their performance. and encourage skill development. The question that comes to mind is: could identifying errors committed by chemistry students in qualitative chemical analysis be per of solution to students' poor performance? This is the focus of this study. The study sort to identified some of the common errors chemistry students committed during qualitative chemical analysis on one hand and find out which one could have higher mean effect on students' performance in chemistry.

Purpose of the Study.

The study investigates the factors that contribute to students' poor performance in qualitative analysis. Specifically, the objective of the study is to;

- i. To identify the nature of errors students often make during qualitative analysis.

- ii. To ascertain the intensity (high/negligible) of errors/mistakes committed during quantitative analysis

Research Questions

The study was guided by the following research questions

- i. What is the mean score of the common errors committed by students during qualitative analysis?
- ii. What is the percentage score of the errors committed by chemistry students in qualitative analysis?

Methodology

The study adopted a descriptive survey research design. This design was considered appropriate for the study as it's allowed the researcher to gather information on some of the common errors committed by chemistry students in qualitative analysis. According to Emaiku (2012) a descriptive survey research is that which does not require the testing of hypothesis but concerns with a systematic description of events. The study involved 1,234 final-year Senior Secondary III (SSIII) students from all 12 senior secondary schools in Shendam Local Government Area council of Plateau State. 100 students were randomly sampled from a purposively sample five senior secondary schools in Shendam area council for the study.

One instrument, Pre-determined Common Errors Committed by Chemistry Students Qualitative Analysis (PCECCSQA). The (PCECCSQA) consisted of 12 structured items which evaluates some common errors students could make during qualitative analysis and its includes observing changes in color, smell, litmus change, parallax error, identification of gases, heating of mixtures, description of substances, drawing inferences, and as well recording of result. Evaluators were requested to record the frequency of errors committed by each respondent while conducting qualitative analysis test. The students were scored 3 points for each error made. The weighted mean score was calculated for each student, and errors were rated as negligible, moderately grievous, or highly grievous based on the following scales: 0.10-0.39 (grievous), 0.40-0.69 (moderately grievous), and 0.70 and above (highly grievous). The frequency and percentage of each error was then computer to determine which error students committed most during qualitative analysis in chemistry practical.

The PCECCSQA was validated by two experts in chemistry education drawn from University of Jos. They were as to determine the content and face validity and as well the construct validity of the PCECCSQA. Their constructive advice was used in developing the final instrument which as used.in order to determine the internal consistency of the instrument a pilot test was conducted in two senior secondary schools in Shendam Local Government Area who were part of the population but do not formed part of the sample for the study. Data collected were used to compute the reliability of the PCECCSQA using Kuder Richardson K-20 formula which yielded an internal consistency of 0.78, this was considered adequate (Pollant, 2001)

Five research assistants were trained as evaluators on the use of PCECCSQA for two weeks. They were trained on how to rate students' error without biases and to accurately monitor the practical periods. They were advised to pay attention to the twenty students selected in each of the chosen schools for the study.

Results

The result gather was tabulated to answer the research questions stated

Table 1: Mean and Frequency Scores of some Common Errors by Students in Qualitative Analysis in Chemistry

S/NO	Items	Frequency	Mean
1.			
2.	Parallax error.	28	0.78
3.	Description of substances.	20	0.56
4.	Identification of colour changes.	16	0.44
5.	Use of indicators.	20	0.56
6.	Identification of gases.	28	0.78
7.	Handling of reagents.	32	0.89
8.	Heating of reagents.	24	0.67
9.	Separation of mixtures	20	0.56
10.	correct observation	32	0.89
11.	Correct inference.	37	1.03
12.	Confirmation test	36	1.00
13.	Report.	32	0.89

Table 1 reveals the frequency count and mean of some common errors chemistry students made in qualitative analysis. The table revealed that moderately grievous errors committed by students were description of substances, identification of gases, use of indicators, heating of reagents, separation of mixtures, with a weighted mean scores below between 0.40-0.69. However it was revealed on Table 1 that chemistry students committed very grievous errors in chemistry qualitative analysis in handling reagents, correct observation, drawing correct inferences, identification of gases, parallax, confirmation test, and report with a weighted mean scores between 0.70- above. it was concluded that chemistry students commit grievous errors during qualitative analysis in writing correct inferences, confirmatory test and reporting practical with mean scores of 1.03 and 1.00 respectively.

Table 2: Mean and Percentage Scores of some Common Errors by Students in Qualitative Analysis in Chemistry

S/NO	Items	Mean	Percentage
1.	Parallax error.	0.78	26.00
2.	Description of substances.	0.56	18.67
3.	Identification of colour changes.	0.44	14.67
4.	Use of indicators.	0.56	18.67
5.	Identification of gases.	0.78	26.00
6.	Handling of reagents.	0.89	29.67
7.	Heating of reagents.	0.67	22.33
8.	Separation of mixtures	0.56	18.67
9.	correct observation	0.89	29.67
10.	Correct inference.	1.03	34.33
11.	Confirmation test	1.00	36.00
12.	Report.	0.89	29.67

Table 2 reveals the mean and percentage count of some common errors chemistry students made in qualitative analysis. The table revealed that some of the highly grievous errors committed by students includes errors such as description of substances, identification of gases, use of indicators, heating of reagents, separation of mixtures, with a percentage count of between 14.00% to 22.90%. However it was revealed on Table 2 that chemistry students committed highly grievous errors in chemistry qualitative analysis such as handling reagents, correct observation, drawing correct inferences, confirmation test, parallax, identification of gases, and report with a percentage count of between 23.00-36.00%. It was concluded that chemistry students commits much more grievous errors during qualitative analysis in writing correct inferences, confirmatory test and reporting practical as shown in their percentage count of 34%,3% and 29.67% respectively

Discussion

The findings revealed common errors committed by students during qualitative analysis, which contribute to the low performance in chemistry in external examinations at the senior secondary school level. This is in conformity with the findings of Olayemi (2000), Ezeliora (2001), Nwosu (2000) and Jimoh (2001) whose study reported that most investigations in chemistry identified factors responsible for low achievement without actually finding out the aspects of chemistry that poses problems to students during chemistry practical. These findings agree with Ayodele (1999), who reiterates the fact that the process skills of science could be achieved only when science students are exposed to sufficient practical work and laboratory experiments because common errors exposed in these findings causing students' low performance in qualitative analysis

can be addressed when students are exposed to more practical periods as the saying goes that ``practice makes perfect``.

Conclusion

It can therefore be concluded that this study has highlighted that students commit certain errors during qualitative analysis and that the errors committed are in varying degrees of intensity. Chemistry students in plateau state senior secondary schools face challenges in qualitative analysis practical. Furthermore, this could contribute to the reasons for the low performance in chemistry at WAEC/NECO/NABTEB, examinations respectively.

Recommendations

1. **Enhancing Practical Exposure:** Schools should allocate more time for practical sessions in the chemistry curriculum. Additional practical periods will give students more opportunities to engage with experiments, correct errors, and reinforce their understanding of qualitative analysis. Teachers should incorporate more hands-on activities that emphasize the importance of accurate observation, correct procedures, and systematic reporting.
2. **Improving Teacher Training and Professional Development:** Chemistry teachers should undergo regular training programs focused on effective teaching strategies for practical chemistry. Teachers should be trained on how to guide students through the practical process, helping them recognize common errors and providing immediate corrective feedback. Teachers should also be encouraged to develop innovative ways to teach qualitative analysis, utilizing both traditional and modern teaching methods to cater to diverse learning styles.
3. **Provision of Adequate Resources:** The government and school authorities should ensure that schools are well-equipped with the necessary laboratory apparatus, reagents, and textbooks to facilitate quality practical chemistry teaching. The provision of adequate resources will enable students to perform experiments with the appropriate materials, thus minimizing errors associated with poorly equipped laboratories.
4. **Fostering Collaborative Learning:** Students should be encouraged to collaborate during practical sessions, as peer learning can provide an opportunity for them to learn from each other's strengths and correct mistakes collectively. Group work can also foster better communication and critical thinking skills, which are essential for accurate qualitative analysis.
5. **Emphasizing the Importance of Report Writing:** Teachers should place more emphasis on the importance of accurate and clear report writing in chemistry practical. Many students struggle with reporting their results effectively, which leads to the failure to communicate their findings accurately. Regular feedback on students' practical reports will help them improve their writing skills and understand the importance of documenting experimental results.
6. **Strengthening Monitoring and Evaluation:** Schools should implement a more rigorous system for monitoring and evaluating students' performance in practical chemistry. Regular assessments, both formative and summative, can help identify specific areas where students are struggling and

provide targeted interventions. Teachers should use various forms of assessment, such as quizzes, group discussions, and practical tests, to evaluate students' understanding and practical skills.

7. Curriculum Review and Updates: There is a need for a continuous review and updating of the chemistry curriculum to ensure that it aligns with current trends in science education. The curriculum should emphasize the development of practical skills and problem-solving abilities, particularly in qualitative analysis, as these are critical for students' success in future scientific endeavors.

By implementing these recommendations, it is hoped that students' understanding of qualitative analysis will improve, thereby enhancing their overall performance in chemistry. The identification of common errors in qualitative analysis is an important step towards addressing the root causes of poor performance in chemistry practicals and providing a more effective learning experience for students.

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