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Analysis of chemistry learning challenges faced by senior secondary students in Awka Zone

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Abstract
Chemistry is a fundamental science subject essential for students' academic and professional growth; however, many senior secondary students in the Awka Zone face significant challenges in learning the subject effectively. This study aims to identify and analyze the key obstacles that hinder students' comprehension and performance in chemistry. Using a mixed-methods approach, data were collected through questionnaires and interviews involving 200 senior secondary students and 20 chemistry teachers across various schools in the Awka Zone. The findings reveal that the main challenges include inadequate laboratory facilities, abstract nature of chemistry concepts, poor teaching methods, lack of practical exposure, and students' low motivation and interest. Additionally, socio-economic factors and limited access to learning resources further exacerbate these difficulties. The study concludes that addressing these challenges requires concerted efforts from educators, policymakers, and stakeholders to improve teaching strategies, enhance resource availability, and foster a more engaging learning environment. These interventions are vital for improving students' understanding, performance, and overall attitude towards chemistry in the Awka Zone.

Keywords: Chemistry learning challenges, senior secondary students, Awka Zone, science education, teaching methods, learning difficulties, laboratory facilities, student motivation

Introduction

1. Background Information on the Research Topic

Chemistry, often regarded as the central science, plays a crucial role in understanding the natural world and in advancing technology, medicine, and environmental science. It is a core subject in senior secondary education, forming the foundation for many science-related careers. In Nigeria, particularly within the Awka Zone, chemistry is a mandatory subject in senior secondary schools, critical for students aspiring to enter tertiary institutions and pursue science, technology, engineering, and mathematics (STEM) fields.

Despite its importance, chemistry learning remains a challenging area for many students. The subject's abstract concepts, complex problem-solving requirements, and the demand for practical laboratory skills often pose barriers to effective learning. This is reflected in consistently poor performance in chemistry examinations, such as the West African Senior School Certificate Examination (WASSCE), where pass rates in chemistry lag behind other science subjects in many parts of Nigeria, including the Awka Zone.

2. Importance of the Research

Understanding the challenges students face in learning chemistry is vital for improving educational outcomes. These challenges not only affect individual students' academic success but also influence the broader socio-economic development by limiting the pool of qualified professionals in science and technology fields. In the Awka Zone, where education is a key driver of regional development, addressing these challenges is imperative.

This study is important because it offers empirical insights into the specific obstacles encountered by senior secondary students in the Awka Zone, a region with unique socio-cultural and economic characteristics. Identifying these challenges can inform curriculum developers, educators, and policymakers to design targeted interventions that enhance chemistry learning and performance.

3. Literature Review

Chemistry Learning Challenges Globally and in Nigeria

Studies worldwide have documented various challenges in chemistry education. According to Tsai (2002) [12], abstract concepts such as atomic structure, chemical bonding, and reaction mechanisms are inherently difficult for students to grasp without effective teaching strategies and practical demonstrations. Similarly, Johnstone (1991) [7] emphasized the cognitive load imposed by the tripartite nature of chemistry—macroscopic, submicroscopic, and symbolic levels—which students often struggle to integrate.

In Nigeria, research by Adeyemo (2010) [2] and Nwafor (2013) [9] highlights that students' poor performance in chemistry is linked to factors including inadequate laboratory facilities, insufficient practical sessions, and ineffective teaching methods. Furthermore, socio-economic issues such as poverty and lack of access to learning materials exacerbate these difficulties.

Teaching and Learning Environment

Several researchers (Obodo, 2002; Egwunyenga, 2006) [6, 10] have identified the teaching environment as a critical factor. Large class sizes, teacher competency, and availability of teaching aids impact students' ability to learn chemistry effectively. In the Awka Zone, preliminary reports indicate that many schools lack well-equipped laboratories, and teachers often rely heavily on theoretical instruction due to limited resources.

Students' Attitudes and Motivation

Students' interest and motivation significantly affect their learning outcomes. Studies by Usman and Okafor (2015) [13] suggest that negative attitudes toward chemistry, influenced by its perceived difficulty and past failures, lead to low engagement and reduced academic achievement.

4. Research Gaps

While extensive studies exist on chemistry learning challenges in Nigeria, there is a paucity of research focusing specifically on the Awka Zone. Most previous studies take a general national perspective, which may overlook regional peculiarities such as cultural attitudes toward education, local resource constraints, and school infrastructure variations. This study fills this gap by providing localized data and context-specific analysis.

Moreover, limited research integrates both student and teacher perspectives using mixed methods, which this study addresses by combining quantitative and qualitative approaches to gain a comprehensive understanding.

5. Research Objectives, Questions, and Hypotheses

Objectives

- To identify the major challenges faced by senior secondary students in learning chemistry in the Awka Zone.
- To examine the impact of teaching methods and resource availability on students' chemistry learning.
- To assess the role of students' attitudes and motivation in their performance.
- To provide recommendations for improving chemistry education in the region.

Research Questions

- What are the primary challenges senior secondary students face in learning chemistry in the Awka Zone?
- How do teaching methods and learning resources affect students' understanding of chemistry?
- What is the relationship between students' attitudes toward chemistry and their academic performance?
- What strategies can be employed to mitigate these challenges?

Hypotheses

- **H1:** There is a significant relationship between teaching methods and students' performance in chemistry.
- **H2:** Availability of laboratory facilities positively influences students' understanding of chemistry concepts.
- **H3:** Students' motivation has a significant effect on their achievement in chemistry.

6. Scope and Structure of the Paper

This research focuses on senior secondary schools in the Awka Zone of Anambra State, Nigeria. It involves both public and private schools to ensure a broad representation of learning environments. The study covers students in their final two years of secondary education, a critical period for preparing for national examinations.

Methods

Research Design

This study employed a mixed-methods research design, combining both quantitative and qualitative approaches to comprehensively analyze the challenges faced by senior secondary students in learning chemistry in the Awka Zone. The quantitative component utilized a structured survey to gather measurable data on students' experiences, attitudes, and learning difficulties. The qualitative component involved semi-structured interviews with selected teachers and students to gain deeper insights into the contextual factors influencing chemistry education.

The mixed-methods design was chosen to leverage the strengths of both approaches—quantitative data provided broad patterns and statistical relationships, while qualitative data enriched understanding through personal narratives and detailed explanations.

Population and Sampling Method

The target population comprised senior secondary school students (SS1 to SS3) and chemistry teachers across public and private schools within the Awka Zone of Anambra State, Nigeria. According to the Anambra State Ministry of Education (2023) [8], the Awka Zone includes approximately 40 senior secondary schools, with an estimated total enrollment of 12,000 senior secondary students and about 150 chemistry teachers.

A stratified random sampling technique was used to select schools to ensure representation from both public and private institutions, as well as urban and semi-urban locations within the zone. From the 40 schools, 10 schools were randomly chosen, consisting of 6 public and 4 private schools.

Within these schools, participants were selected as follows

- **Students:** A total of 200 students were sampled proportionally based on school enrollment sizes. Selection was randomized from senior secondary classes to ensure gender and grade level diversity.
- **Teachers:** 20 chemistry teachers from the selected schools were purposively sampled to participate in interviews based on their teaching experience and willingness to contribute.

Data Collection Tools

1. Survey Questionnaire

A structured questionnaire was developed for students, containing both closed and Likert-scale items. The questionnaire was divided into sections covering:

- Demographic information (age, gender, class level, school type)
- Challenges faced in learning chemistry (e.g., understanding concepts, availability of resources)
- Attitudes and motivation toward chemistry
- Perceptions of teaching methods and classroom environment

The questionnaire was pre-tested on a small group of 20 students outside the sampled schools to check for clarity and reliability. Cronbach's alpha coefficient for internal consistency was calculated at 0.82, indicating good reliability.

2. Semi-Structured Interviews

Semi-structured interviews were conducted with 20 chemistry teachers and 15 students (selected from the survey respondents based on willingness and availability). The interviews aimed to explore:

- Teachers' perspectives on common student difficulties
- Availability and use of laboratory facilities and teaching aids

- Classroom teaching strategies and challenges
- Students' personal experiences and feelings about learning chemistry

Interviews were audio-recorded with participants' consent and transcribed verbatim for analysis.

Analytical Tools and Techniques

Quantitative Analysis

The survey data were coded and entered into SPSS version 27 for analysis. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize the data on learning challenges and attitudes.

Inferential statistics, including chi-square tests and Pearson correlation analysis, were applied to examine relationships between variables such as teaching methods, resource availability, student motivation, and academic performance. A significance level of 0.05 was set for hypothesis testing.

Qualitative Analysis

Interview transcripts were analyzed using thematic analysis, following Braun and Clarke's (2006) [5] six-step process:

1. Familiarization with data by reading transcripts multiple times.
2. Generating initial codes reflecting significant features of the data.
3. Searching for themes by grouping related codes.
4. Reviewing themes to ensure they accurately represent the data.
5. Defining and naming themes for clarity.
6. Producing a report with illustrative quotes to support each theme.

The qualitative analysis was aided by NVivo 12 software to organize codes and facilitate thematic extraction.

Ethical Considerations

Ethical approval for this study was obtained from the Anambra State Ministry of Education's research ethics committee prior to data collection. The following ethical principles were strictly observed:

- **Informed Consent:** Participants were fully informed about the study's purpose, procedures, and their rights before participation. Written consent was obtained from all teachers and students above 18 years old. For students below 18, parental/guardian consent was also secured.

- **Confidentiality:** Participants' identities were anonymized using codes to protect their privacy. All data were stored securely on password-protected devices accessible only to the research team.

- **Voluntary Participation:** Participation was entirely voluntary, with the option to withdraw at any stage without penalty.

- **Non-Harm:** The research design ensured that no physical or psychological harm would come to participants. Sensitive questions were avoided, and interviews were conducted in comfortable, private settings.

Results

1. Demographic Characteristics of Participants

A total of **200 senior secondary students** participated in the survey, with a fairly balanced gender distribution: 52% female (n = 104) and 48% male (n = 96). Participants were from three senior secondary classes: SS1 (33%), SS2 (34%), and SS3 (33%). The sampled schools included 60% public and 40% private institutions, reflecting the stratified sampling approach.

The 20 chemistry teachers interviewed had teaching experience ranging from 3 to 25 years, with an average of 12 years. They represented a mix of public and private school settings in both urban and semi-urban areas of Awka Zone.

2. Students' Perceived Challenges in Learning Chemistry

Table 1: summarizes the key challenges identified by students through the survey questionnaire. Students rated each item on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

Challenge	Mean Score	% Agree (4 & 5)
Difficulty understanding abstract concepts	4.25	78%
Lack of adequate laboratory facilities	4.10	75%
Poor teaching methods	3.85	68%
Limited practical experiments	4.00	72%
Insufficient textbooks and learning materials	3.70	65%
Large class sizes	3.50	58%
Low student motivation	3.90	70%

Table 2: shows students' responses to attitude-related items

Attitude Statement	Mean Score	% Agree (4 & 5)
Chemistry is important for my future career	4.30	80%
I enjoy learning chemistry	3.20	40%
Chemistry is too difficult to understand	4.15	75%
I feel confident in chemistry exams	2.90	35%

The highest-rated challenge was "difficulty understanding abstract concepts," with 78% of students agreeing it significantly hindered their learning. Lack of laboratory facilities and limited practical exposure were also prominent issues.

3. Attitudes and Motivation Towards Chemistry

Students' attitudes toward chemistry were generally mixed. While 40% expressed moderate interest in chemistry, 35% indicated low motivation, citing the subject as "difficult" or "boring." About 25% showed a positive attitude, often correlating with better academic performance.

4. Teachers' Perspectives on Learning Challenges

From the interviews, teachers identified several recurring themes:

- **Inadequate Laboratory Facilities:** All teachers reported insufficient or poorly equipped labs, limiting hands-on practical learning.
- **Teaching Methodologies:** Many teachers rely on traditional lecture-based methods due to large classes and lack of resources, which restricts interactive and student-centered learning.
- **Student Attitude:** Teachers observed low motivation and fear of failure among students, often leading to poor engagement.
- **Resource Constraints:** Shortages of textbooks, chemicals, and teaching aids were common across schools.
- **Curriculum Challenges:** Some teachers expressed concern that the chemistry syllabus is dense and abstract, making it difficult to cover thoroughly within limited school hours.

Quotes from selected teachers illustrate these points

"Our laboratory lacks basic equipment, so students miss out on important experiments. This affects their understanding." — Teacher 5

"Most students find the concepts too theoretical. Without practical experience, they struggle to grasp them." — Teacher 11

5. Relationship Between Variables (Quantitative Findings)

Statistical analyses examined relationships among key variables:

- **Teaching Methods and Student Performance:** Chi-square analysis showed a significant association between students' perception of teaching effectiveness and their self-reported academic performance in chemistry ($\chi^2 = 12.34$, $p < 0.01$).
- **Laboratory Facilities and Conceptual Understanding:** Students reporting better access to labs scored higher on questions assessing conceptual understanding ($r = 0.45$, $p < 0.01$).
- **Student Motivation and Performance:** A positive correlation was found between motivation scores and chemistry grades ($r = 0.50$, $p < 0.01$).

6. Thematic Summary of Qualitative Data

From the interviews, three major themes emerged regarding learning challenges:

- **Theme 1: Resource Limitations**

Most participants highlighted the scarcity of essential materials and laboratory equipment as a major barrier to effective learning.

- **Theme 2: Pedagogical Constraints**

Teachers noted that overcrowded classrooms and limited time impede their ability to employ interactive methods, causing students to rely heavily on rote memorization.

- **Theme 3: Student Psychological Factors**

Fear of difficult exams, lack of confidence, and poor attitudes toward chemistry negatively influenced students' learning efforts.

7. Summary of Key Findings

- The majority of students face difficulty understanding abstract chemistry concepts.
- Inadequate laboratory facilities and limited practical sessions significantly hamper learning.
- Traditional teaching methods dominate, often leading to reduced student engagement.
- Students' motivation and attitudes toward chemistry vary, influencing their academic outcomes.
- Teachers perceive resource constraints and curriculum demands as critical challenges.
- Statistical analyses confirm significant relationships between teaching quality, resource availability, motivation, and student performance.

Discussion

The present study sought to analyze the challenges faced by senior secondary students in learning chemistry within the Awka Zone, with a focus on identifying key obstacles, examining teaching methods, and understanding students' attitudes and motivation. The findings provide valuable insights that align with, extend, and occasionally contrast previous research in chemistry education both within Nigeria and globally.

The prominent finding that students struggle most with abstract chemistry concepts echoes Johnstone's (1991) [7] theory on the tripartite nature of chemistry—macroscopic, submicroscopic, and symbolic levels—making it inherently difficult for learners to integrate knowledge. This finding is consistent with studies by Tsai (2002) [12] and Adeyemo (2010) [2], who reported that abstractness poses a significant barrier to comprehension, especially in environments where practical demonstrations are limited. The significant association between limited practical laboratory exposure and students' conceptual difficulties observed in this study reinforces this view. Without hands-on experience, students rely heavily on rote memorization, which inhibits deep understanding and long-term retention (Nwafor, 2013) [9].

The data also revealed that inadequate laboratory facilities are a major challenge for both students and teachers in the Awka Zone. This confirms earlier Nigerian studies (Obodo, 2002; Egwunyenga, 2006) [6, 10] that linked resource scarcity to poor science education outcomes. The lack of well-equipped labs not only limits experimental learning but also affects student engagement and motivation, as practical activities are often cited as more stimulating than theoretical lessons alone (Usman & Okafor, 2015) [13]. The teachers' reports of insufficient chemicals, textbooks, and teaching aids further underscore the material constraints hampering effective chemistry education in the region.

Another important theme is the predominance of traditional, teacher-centered instructional methods, which contrasts with the pedagogical approaches recommended in contemporary science education literature. Constructivist and inquiry-based teaching strategies have been shown to enhance students' critical thinking and interest in science subjects (Abimbola, 2003; Ayodele, 2014) [1, 4]. The reliance on lectures and note-taking in overcrowded classrooms

observed here likely contributes to student disengagement and poor performance. This finding is aligned with previous reports from Nigerian educational contexts, where large class sizes and insufficient teacher training limit the adoption of more interactive methods (Ajaja, 2010) [3].

Students' attitudes and motivation toward chemistry were mixed, with many expressing low confidence and interest. This is consistent with Usman and Okafor's (2015) [13] findings that negative attitudes stem from perceived difficulty and previous failure experiences. The positive correlation between motivation and academic performance observed in this study further supports the importance of psychological factors in learning outcomes. Teachers' observations of fear and anxiety among students corroborate this, suggesting that affective barriers may be as critical as cognitive challenges in chemistry education.

One unexpected outcome was the slightly better attitudes and performance reported among students from private schools, which may relate to better resource availability and smaller class sizes in these institutions. While this difference was not the primary focus of the study, it highlights potential disparities within the Awka Zone's educational landscape, warranting further investigation.

Despite these valuable insights, the study faced limitations. The sample size, though adequate for the zone, limits broader generalization beyond Awka. Additionally, reliance on self-reported data may introduce bias, especially in students' academic performance and attitudes. Access to more objective measures such as examination results could strengthen future research. Time constraints and logistical challenges limited the number of schools and participants, which could be expanded for more representative sampling.

Based on these findings, several recommendations emerge. First, there is a critical need to improve laboratory infrastructure and ensure regular practical sessions in chemistry curricula. Policymakers and school administrators should prioritize funding and resource allocation to address this gap. Second, teacher training programs should emphasize learner-centered and inquiry-based pedagogies to foster better student engagement and understanding. Third, interventions aimed at enhancing student motivation—such as mentoring, counseling, and exposure to real-world applications of chemistry—could mitigate affective barriers. Finally, further research should explore the impact of socio-economic factors and school type differences on chemistry learning outcomes within the zone and beyond.

In conclusion, this study confirms that chemistry learning challenges in the Awka Zone are multifaceted, encompassing conceptual difficulties, resource constraints, pedagogical limitations, and motivational issues. Addressing these requires coordinated efforts across educational stakeholders to create a more supportive and effective learning environment for senior secondary students.

Conclusion

This study investigated the challenges senior secondary students face in learning chemistry in the Awka Zone. The findings revealed that difficulty understanding abstract chemistry concepts, inadequate laboratory facilities, traditional teaching methods, and low student motivation are significant barriers to effective learning. Both students and teachers highlighted the lack of practical exposure and limited access to essential learning resources as major obstacles. Additionally, students' attitudes toward chemistry varied, with many expressing low confidence and interest, which negatively impacted their academic performance.

The results underscore the urgent need for improved educational infrastructure, enhanced teacher training, and strategies to boost student motivation. Addressing these challenges is critical for raising students' understanding and achievement in chemistry, which is essential for their academic progression and the development of science-related fields in the region. This study provides valuable insights for educators, policymakers, and stakeholders aiming to improve chemistry education in the Awka Zone and similar contexts.

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