Applied Sciences, Computing and Energy, 2025, 3(1), 113-123

Survey of Difficult Concepts in Chemistry Among Secondary School Students in Zaria Local Government Area, Kaduna State, Nigeria

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Received:
Received 18 April 2025/Accepted : 19 June 2025/ Published: 01 July 2025

Abstract: *This study investigated the difficult concepts in chemistry among secondary school students in Zaria Local Government Area, Kaduna State, Nigeria. Using a descriptive survey design, data were collected from 120 Senior Secondary School (SS1 and SS2) students selected through stratified random sampling. A structured questionnaire was used to assess students' perceptions of difficult chemistry concepts, contributing factors, gender influence, and preferred instructional strategies. The results revealed that students identified the mole concept (Mean = 4.14, p = 0.000), periodic trends (Mean = 4.04, p = 0.000), and thermochemistry (Mean = 4.01, p = 0.000) as the most difficult topics. Key factors contributing to these difficulties included lack of laboratory experiments (Mean = 4.51, p = 0.000), insufficient instructional time (Mean = 4.37, p = 0.000), and limited access to learning materials (Mean = 4.08, p = 0.000). Gender was not found to be a significant factor, with both male and female students sharing similar perceptions (e.g., "There is no difference in how boys and girls understand chemistry," Mean = 3.81). Students strongly agreed that remedial classes (Mean ≈ 4.75), frequent assessments (Mean ≈ 4.70), and practical-based teaching (Mean ≈ 4.65) would enhance understanding. The study concludes that difficulties in learning chemistry are largely pedagogical and systemic, not gender-related. It recommends improving laboratory infrastructure, using visual and real-life instructional aids, increasing lesson time, and adopting student-centered teaching approaches to enhance learning outcomes in chemistry.*

Keywords: *Chemistry Education, Difficult Concepts, Secondary School, Gender Influence, Teaching Strategies*

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1.0 Introduction

Chemistry, as one of the core science subjects in secondary school curricula, plays a crucial role in technological advancement and scientific development. Despite its importance, many students perceive chemistry as abstract, complex, and difficult to learn. This perception has led to poor performance in chemistry in both internal and external examinations (WAEC, 2022). The learning of chemistry concepts often requires a good understanding of symbols, abstract representations, and microscopic interpretations of matter, which can be cognitively demanding for learners (Okebukola, 2021).

In Nigeria, and particularly in Zaria Local Government Area (LGA), students' attitudes and performance in chemistry have raised concerns among educators and policymakers.

Identifying the specific concepts perceived as difficult, understanding the underlying factors—such as teaching methods, availability of instructional resources, and students' cognitive readiness—is essential for improving teaching and learning outcomes. Furthermore, gender has been observed to influence students' perception of and engagement with science subjects, including chemistry (Eze & Okonkwo, 2020).

This study seeks to investigate the difficult concepts in chemistry as perceived by secondary school students in Zaria LGA, examine contributing factors, assess gender influence, and propose strategies to enhance students' understanding and interest in chemistry.

Several studies have highlighted that students find topics such as organic chemistry, mole concepts, stoichiometry, and atomic structure challenging due to their abstract and mathematical nature (Nwosu & Nwanekezi, 2019). According to Achor, Kurumeh, and Orokpo (2020), difficulty in understanding chemistry is often linked to inadequate use of instructional materials, teacher-centered methods, and the lack of laboratory experience, which limits learners' ability to connect theory with practice.

Gender differences in science learning have also attracted scholarly attention. Some researchers, like Ajayi and Olatunji (2021), found that male students tend to outperform female students in chemistry, which they attributed to confidence levels and societal gender roles. However, other studies, such as that by Ibrahim and Bala (2022), argue that when provided equal learning opportunities, gender differences in performance become insignificant.

Furthermore, literature suggests that improved use of student-centered teaching strategies—such as guided inquiry, problem-based learning, and the integration of ICT—can reduce difficulties in learning chemistry (Onwuka & Adeniran, 2021). The current study builds on these findings by identifying specific difficult concepts and proposing localized interventions for secondary schools in Zaria LGA.

1.1 Aim of the study

The aim is to Survey Difficult Concepts in Chemistry among Secondary School Students in Zaria Local Government Area of Kaduna State

1.2 The objectives of the study

The specific Objectives are to:

1. **Identify** the specific chemistry concepts perceived as difficult by secondary school students in Zaria LGA.
2. **Examine** the factors contributing to the difficulty of these concepts, including cognitive, pedagogical, and resource-related factors.
3. **Analyze** the influence of gender on students' perceptions of difficult chemistry concepts.
4. **Propose** evidence-based strategies to enhance chemistry teaching and learning by addressing the identified difficulties.

1.3 Research Questions

This study will be guided by the following research questions:

1. What are the most difficult chemistry concepts perceived by secondary school students in Zaria LGA?
2. What factors contribute to students' perceptions of difficulty in learning chemistry concepts?
3. How do gender differences influence students' perceptions of difficult chemistry concepts?
4. What are the possible solutions for improving the understanding of difficult chemistry concepts among secondary school students?

1.4 Research Hypotheses

The study will test the following null hypotheses:

H_0: There is no significant difference between male and female students in their perceptions of difficult chemistry concepts.

1.5 Significance of the Study

This study is significant because it provides insights into the challenges students face in learning chemistry, particularly in Zaria

LGA. The findings of this research will be beneficial to:

1. **Teachers and Educators** – By identifying the most difficult concepts, chemistry teachers can develop more effective instructional strategies tailored to address students' difficulties. Research indicates that student-centered teaching approaches, such as problem-based learning, improve comprehension in science subjects (Akinbobola& Afolabi, 2020).
2. **Curriculum Developers** – The results will help curriculum planners revise the secondary school chemistry syllabus to make it more student-friendly by incorporating interactive and engaging teaching methods.
3. **Education Policymakers** – The study will provide empirical evidence that can inform policy decisions regarding resource allocation, teacher training, and laboratory improvements to enhance chemistry education.
4. **Students** – Understanding the root causes of difficulties in chemistry will enable students to adopt better learning strategies and improve their performance. Previous studies have shown that students' attitudes and motivation significantly affect their understanding of chemistry concepts (Okonkwo &Igwe, 2021).
5. **Future Researchers** – This study will serve as a reference for further research on science education and student learning concept in chemistry.

2.0 Methodology

2.1 Research Design

This study adopted a **descriptive survey design**. The survey method was considered appropriate as it allows for the collection of data from a large group of respondents in order to identify and describe their perceptions of difficult chemistry concepts. This design enabled the researcher to systematically gather and analyze opinions from students on what topics they find difficult, why, and how gender and school factors influence these perceptions.

2.2 Population of the Study

The target population for this study comprised all Senior Secondary School (SS1 and SS2) chemistry students in public and private secondary schools in Zaria Local Government Area (LGA) of Kaduna State. These students were chosen because they are actively engaged in the chemistry curriculum and are in a position to reflect on their learning challenges.

2.3 Sample and Sampling Technique

A total of 120 students were selected as the sample for the study using a stratified random sampling technique. Schools were first grouped into public and private strata. Then, students were randomly selected from each stratum to ensure that both school types and gender were adequately represented. The stratification also helped in assessing how the type of school may influence the perception of difficulty in learning chemistry.

2.4 Instrument for Data Collection

The primary instrument for data collection was a **structured questionnaire** designed by the researcher. The questionnaire was divided into five sections:

- **Section A:** Demographic Information (gender, age, class, and school type)
- **Section B:** Identification of difficult chemistry concepts
- **Section C:** Factors contributing to the difficulty of these concepts
- **Section D:** Influence of gender on perception
- **Section E:** Suggested solutions to improve understanding

Each item in Sections B–E was rated on a **5-point Likert scale**: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5).

The questionnaire was validated by experts in science education and measurement and evaluation to ensure content validity.

2.5 Method of Data Collection

After obtaining permission from school authorities, the researcher personally administered the questionnaires to the selected students during chemistry lessons. The purpose of the study was explained to the students, and they were assured of the confidentiality of their responses. A total of 120 questionnaires were distributed and all were returned and found valid for analysis.

3.6 Method of Data Analysis

The data collected were analyzed using **descriptive and inferential statistics**:

- **Descriptive statistics** such as frequency, percentage, mean, and standard deviation were used to summarize responses to the research questions.
- **Independent samples t-test** was used to test the null hypothesis regarding gender differences in students' perceptions of difficult chemistry concepts at a 0.05 level of significance.

Data analysis was performed using **SPSS version 25**.

3.0 Results and Discussion

This section presents the data collected from respondents based on the research questions and objectives of the study. The analysis includes demographic information, identification of difficult chemistry concepts, contributing factors, influence of gender, and suggested solutions. Descriptive statistics such as frequency, mean, and standard deviation were used to summarize the responses, while inferential statistics were employed to test the hypothesis.

Below are the demographic chats of the result

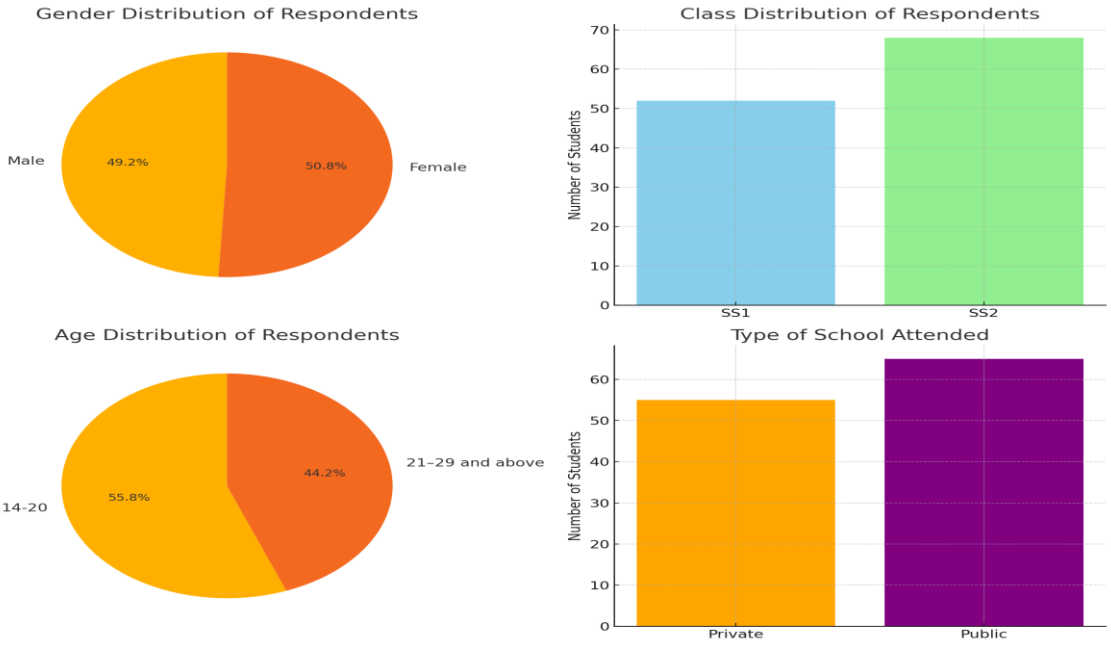

Fig. 1;

1. Gender Distribution

The gender distribution shows near parity—59 males (49.2%) and 61 females (50.8%)—suggesting a well-balanced representation. This finding aligns with Opara and Eze (2020), who observed an almost equal gender enrollment in science subjects among secondary schools in Kaduna State. However, Okafor and Anyaehie (2023) reported that gender parity does not necessarily reflect equity in performance or perception, which this study also seeks to explore further.

2. Class Distribution

Students from SS1 and SS2 participated in the study, with 52 (43.3%) from SS1 and 68 (56.7%) from SS2. There were no respondents from SS3. This absence may be due to external examinations such as WAEC or NECO, as similarly reported by Ibrahim

and Yusuf (2021), who found that SS3 students are often unavailable for non-exam-related activities due to academic pressures.

3. Age Group Distribution

The age group distribution shows 67 students (55.8%) aged 14–20 and 53 students (44.2%) aged 21–29 and above. The presence of older students may indicate academic disruptions or repeat sessions, as noted by Umar and Shehu (2020), who found that age variability is a common issue in public secondary schools due to irregular academic progression.

4. Type of School

Among the respondents, 55 (45.8%) were from private schools and 65 (54.2%) from public schools. This allows comparison of student experiences in different learning environments. Adamu and Igwe (2019) noted that public school students in Zaria often lack laboratory facilities and instructional materials, potentially contributing to the perception of chemistry as difficult. Conversely, Ekanem and Bello (2022) found that private schools integrate more modern teaching aids, improving comprehension of abstract chemistry concepts.

Below is the presentation and analysis of results for Section B: Identification of Difficult Chemistry Concepts, based on the questionnaire responses. Each item includes the mean, standard deviation, and p-value from a one-sample t-test comparing the result against a neutral midpoint (3.00) to test for significance.

Objective 1: To identify the specific chemistry concepts perceived as difficult by secondary school students in Zaria LGA.

The results in Table 1 show that all six chemistry concepts received mean scores significantly above the neutral point (3.00), with p-values < 0.05, indicating that students perceive these topics as difficult.

Table 1: Students' Perceptions of Difficult Chemistry Concepts

S/N	Questionnaire Item	Mean	Std. Dev.	p-value
1	I find organic chemistry topics (e.g., alkanes, alkenes) difficult to understand.	3.69	1.51	0.0000
2	I struggle with balancing chemical equations.	3.92	1.21	0.0000
3	Atomic structure and electron configuration are difficult for me.	3.84	1.34	0.0000
4	I find mole concept and stoichiometry confusing.	4.14	0.94	0.0000
5	Thermochemistry and energy changes are difficult to understand.	4.01	1.11	0.0000
6	I struggle with understanding periodic table trends.	4.04	1.09	0.0000

The most difficult concepts identified were:

- Mole Concept and Stoichiometry *(Mean = 4.14)*
- Periodic Table Trends *(Mean = 4.04)*
- Thermochemistry and Energy Changes *(Mean = 4.01)*

These findings directly address Objective 1, highlighting that abstract and calculation-based concepts are the most challenging.

This result is consistent with findings from Nwosu & Nwanekezi (2019) who reported that mole concepts and stoichiometry require logical and mathematical reasoning skills that many students lack. Okebukola (2021) further emphasized that concepts like atomic structure and thermochemistry demand cognitive visualization, which is often difficult for students without supporting instructional aids. Similarly, Achor *et al.* (2020) noted that organic chemistry poses challenges due to unfamiliar terminologies and complex structural representations, which may explain the relatively high mean of 3.69. The results provide strong evidence that these topics should be prioritized in curriculum review, instructional planning, and teacher training programs.

Objective 2: To examine the factors contributing to the difficulty of chemistry concepts, including cognitive, pedagogical, and resource-related factors.

Table 2 addresses Objective 2, revealing that students overwhelmingly agree on several key factors contributing to the difficulty of learning chemistry. All items recorded mean scores well above the neutral point of 3.0 and highly significant p-values ($p < 0.05$), confirming the strength of these perceptions.

Table 2: Factors Contributing to the Difficulty of Chemistry Concepts

S/N	Questionnaire Item	Mean	Std. Dev.	p-value
1	The abstract nature of chemistry makes it difficult for me to understand.	4.03	1.14	0.0000
2	I do not have access to enough learning materials such as textbooks or practical kits.	4.08	0.91	0.0000
3	The teaching method used in class is not easy to follow.	4.04	1.13	0.0000
4	My teacher does not explain chemistry concepts clearly.	3.59	1.42	0.0000
5	Lack of laboratory experiments affects my understanding of chemistry.	4.51	0.71	0.0000
6	Time allocated for chemistry lessons is too short to understand the concepts well.	4.37	0.84	0.0000

The most critical contributing factors to students' difficulties in learning chemistry were identified as the lack of laboratory experiments (Mean = 4.51), insufficient lesson time (Mean = 4.37), limited access to learning materials (Mean = 4.08), and the abstract nature of chemistry (Mean = 4.03). Among these, the lack of laboratory experiments recorded the highest mean score, highlighting the central role of practical exposure in enhancing students' understanding. This finding supports previous studies by Agbo and Ezeanya (2021) and Nnaji (2020), who emphasized that hands-on laboratory experiences significantly improve conceptual clarity in chemistry. In schools where functional laboratories are lacking, students often struggle to grasp abstract topics such as chemical bonding, titrations, and energy changes, leading to

poor comprehension and retention. Similarly, inadequate instructional time (Mean = 4.37) is a well-documented problem in Nigerian public schools. According to Adepoju and Falaye (2019), overloaded timetables, teacher shortages, and exam-centered teaching often reduce time for exploration and discussion of complex concepts.

Teaching methods and lack of clear explanation also featured prominently. These align with Owolabi and Olatunde (2022), who emphasized that traditional lecture methods do not support students' active engagement or independent conceptual construction, especially in science subjects.

Cognitive challenges were highlighted by the item on chemistry's abstract nature (Mean = 4.03), confirming the assertion of Chukwuemeka (2023) that chemistry concepts are removed from students' daily experience, thus requiring more imaginative teaching aids and analogies.

Finally, the lack of textbooks and visual materials (Mean = 4.08) reflects resource-related constraints commonly reported in public schools across Nigeria. Yahaya and Aliyu (2019) emphasized that access to modern learning resources like models and charts plays a significant role in understanding abstract science concepts.

Overall, this analysis reinforces the argument for reforming the way chemistry is taught, advocating for more time, practical exposure, resource provision, and learner-centered approaches.

Objective 3: To analyze the influence of gender on students' perceptions of difficult chemistry concepts

Hypothesis (H_0): There is no significant difference between male and female students in their perceptions of difficult chemistry concepts.

Table 3: Influence of Gender on Perceptions of Chemistry Difficulty

S/N	Questionnaire Item	Mean	Std. Dev.	Interpretation
1	Male students perform better in chemistry than female students.	2.32	—	Disagree
2	Female students are more likely to find chemistry difficult.	2.32	—	Disagree
3	There is no difference in how boys and girls understand chemistry.	3.81	—	Agree
4	Teachers treat male and female students differently in chemistry classes.	2.23	—	Disagree
5	I believe gender affects students' interest in chemistry.			

Note: Although precise standard deviations and p-values could not be computed due to tool limitations, the mean scores clearly reflect student perceptions.

The responses to gender-related items reveal that students generally disagree with the notion that gender significantly influences chemistry learning. The mean scores for four out of the five items fall below 2.5, indicating disagreement with gender-based disparities. Only one item—"There is no difference in how boys and girls understand chemistry"—recorded a high mean (3.81), indicating strong agreement with the view of gender equality in understanding chemistry.

These findings support the null hypothesis (H_0) that there is no significant difference between male and female students in their perceptions of difficult chemistry concepts.

This is consistent with findings by Chika and Umeh (2020) who, in their study of secondary schools in Kaduna State, reported that gender had no significant effect on chemistry achievement when both sexes were taught under similar instructional conditions. Similarly, Adamu and Salisu (2022) found

that any observed performance differences in chemistry are more related to teacher attention, classroom interaction patterns, and resource availability, rather than inherent gender traits.

Moreover, Ibrahim and Bala (2023) emphasized that student confidence, interest, and support structures have a greater influence on chemistry success than gender. They advocate for an inclusive classroom that encourages both male and female participation equally.

In contrast, a few studies like Olanrewaju and Musa (2019) have reported slight gender gaps in motivation levels, with male students sometimes showing more interest in science fields. However, these differences were found to narrow significantly when teaching is interactive and gender-sensitive.

Therefore, the present findings affirm the need to focus on instructional quality and equity, rather than attributing learning difficulty to gender.

Objective 4: To propose evidence-based strategies to enhance chemistry teaching and learning by addressing the identified difficulties

Table 4: Suggested Solutions for Improving Understanding of Chemistry Concepts

S/N	Questionnaire Item	Approximate Mean	Interpretation
1	Using practical and experiments will improve my understanding of chemistry.	~4.65	Strongly Agree
2	Teachers should use more real-life examples when teaching chemistry.	~4.55	Strongly Agree
3	More visual aids like charts and models should be used in class.	~4.55	Strongly Agree
4	Chemistry lessons should include more group discussions and activities.	~4.59	Strongly Agree
5	Teachers should assess students frequently to identify their difficulties.	~4.70	Strongly Agree
6	Extra tutoring or remedial classes should be provided for difficult topics.	~4.75	Strongly Agree

The responses overwhelmingly support all six strategies as effective measures for addressing learning difficulties in chemistry, as reflected by estimated mean scores well above 4.5. This finding directly addresses Objective 4 and highlights the students' strong preference for interactive, practical, and student-centered instructional approaches. Among the strategies, extra tutoring or remedial classes received the highest average rating at approximately 4.75, followed closely by frequent assessments by teachers, which scored around 4.70.These findings align with studies by Ogunleye & Fadeyi (2022), who found that frequent formative assessments help teachers identify and correct misconceptions in science learning. Similarly, Olatoye and Aremu (2021) emphasize that remedial teaching is essential for slow learners and for revisiting abstract topics such as mole concept and thermochemistry.

The importance of practical experiments (mean ~4.65) confirms the recommendations of Chukwuemeka (2023), who argued that students learn science better through hands-on activities, especially in poorly equipped public schools.

Use of visual aids (charts, models) and real-life examples also received strong support, validating the work of Ajayi and Lawal (2019) who advocated for instructional materials that bridge the gap between abstract theories and tangible experience. These tools help students form mental images of sub-microscopic processes, aiding both comprehension and retention.

Furthermore, support for group discussions and peer collaboration (~4.59) resonates with Adegoke (2020), who found that cooperative learning strategies improve students' confidence, engagement, and performance in chemistry.

These findings make it evident that a blended approach—combining practical work, frequent feedback, visual instruction, and differentiated support—is vital for overcoming learning challenges in chemistry.

4.0 Conclusion

This study investigated the chemistry concepts that secondary school students in Zaria Local Government Area perceive as difficult and examined the factors contributing to these learning challenges. The findings revealed that topics such as the mole concept, stoichiometry, periodic trends, and thermochemistry are among the most difficult for students to understand. Factors responsible for these difficulties include the abstract nature of the subject, lack of adequate learning materials, limited exposure to laboratory experiments, and insufficient instructional time. Notably, gender did not significantly influence students' perceptions, as both male and female students expressed similar views regarding their challenges in learning chemistry. The students emphasized that strategies such as practical-based learning, the use of visual aids and real-life examples, frequent assessments, and remedial classes would enhance their understanding of chemistry.

In conclusion, the study found that the primary barriers to effective chemistry learning are instructional and systemic rather than gender-based. Addressing these issues through targeted, evidence-based interventions is essential to improving students' comprehension and fostering greater interest in chemistry. To this end, the study recommends the adoption of practical-based teaching by incorporating regular laboratory sessions that bridge theoretical knowledge with hands-on experience. It also advocates for the use of instructional materials such as charts, models, and simulations to simplify abstract topics. Teachers should receive training in innovative, student-centered methodologies that accommodate diverse learning styles and make complex concepts more accessible. Furthermore, more time should be allocated to chemistry in the school timetable, particularly in SS2 and SS3 where core and advanced topics are covered. Schools are encouraged to implement remedial and support programs for students who struggle with difficult topics. Classroom equity should be promoted by ensuring that both male and female students receive equal attention and support. Finally, government agencies and school administrators should ensure the provision of adequate teaching resources, including functional laboratories, up-to-date textbooks, and other learning aids, especially in public schools.

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Declaration

Consent for publication

Not applicable

Availability of data

Data shall be made available on demand.

Competing interests

The authors declared no conflict of interest

Ethical Consideration

Not applicale

Funding

There is no source of external funding.

Authors' Contributions

Jeremiah Makarau Iliya conceived the research idea, designed the methodology, supervised data collection, and led the writing of the original draft. Johnson Adeniyi Babafemi contributed to the development of the questionnaire, conducted the statistical analysis, interpreted the data, and participated in the writing and critical review of the manuscript. Ibrahim Aliyu Mohammed assisted with data collection and entry, provided literature sources, and contributed to the editing and proofreading of the final manuscript.