

AVAILABILITY AND UTILIZATION OF LABORATORY FACILITIES IN TEACHING CHEMISTRY IN PUBLIC SENIOR SECONDARY SCHOOLS IN OMOKU RIVERS STATE, NIGERIA

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Abstract: *This study assessed the availability and utilization of laboratory facilities for teaching Chemistry in public senior secondary schools in Omoku, Rivers State, Nigeria. The study was guided by four research objectives. The descriptive survey research design was adopted, with a sample of five Chemistry teachers and 120 SS2 students drawn from the three public secondary schools in Omoku—Community Secondary School (CSS) Omoku. Three instruments were used: a Chemistry Laboratory Facility Inventory and Functionality Assessment Checklist (CLIFAC), a Chemistry Teachers' Utilization and Constraints Questionnaire (CTUCQ), and a Students' Perception and Practical Exposure Questionnaire (SPPEQ). Data were analyzed using descriptive statistics (mean and standard deviations) with a criterion mean of 2.50. The findings revealed severe deficiencies in laboratory facilities across all three schools. Practical Chemistry instruction was severely limited or entirely absent; only CGSS conducted any practical activities, predominantly teacher demonstrations rather than hands-on student participation. Major constraining factors included insufficient funding, lack of water and electricity, inadequate functional apparatus, expired reagents, overcrowded classes, poor infrastructure, absence of safety equipment, and lack of laboratory assistants. Teachers unanimously agreed that laboratory work is essential for conceptual understanding, academic performance, and skill development. Students with some practical exposure affirmed its benefits, while those without reported low self-efficacy and difficulty grasping abstract concepts such as mole concept, titration, and qualitative analysis. The study concluded that the current state of Chemistry laboratory facilities in Omoku's public secondary schools constitutes a crisis that violates constructivist and experiential learning principles, deprives students of essential hands-on experiences, and perpetuates educational inequity. Recommendations include emergency laboratory rehabilitation by the Rivers State Ministry of Education, establishment of annual laboratory audits and zonal reagent revolving funds, deployment of laboratory assistants.*

Keywords: Availability, Utilization, Laboratory Facilities, Chemistry.

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Introduction

Science education is globally recognized as a foundational pillar for national development, economic competitiveness, and technological advancement in the 21st century. It equips citizens with the requisite knowledge, skills, and attitudes to understand and manipulate their environment, solve complex problems, and contribute meaningfully to societal progress. A robust science, technology, engineering, and mathematics (STEM) education ecosystem is indispensable for Nigeria's aspiration to transition toward a knowledge-based economy (Federal Republic of Nigeria, 2013). Within this STEM spectrum, Chemistry holds a uniquely pivotal position. It is often described as the "central science" because it forms the foundational bridge between physics and biology and serves as the bedrock for critical sectors such as healthcare, agriculture, pharmacology, environmental science, and materials engineering. Consequently, the quality of Chemistry education at the secondary school level directly influences the pipeline of future scientists, doctors, engineers, and technologists who will drive national development.

The effective teaching and learning of Chemistry, however, extend far beyond the mere transmission of theoretical knowledge from teacher to student. As extensively documented by educational theorists like John Dewey and proponents of constructivism, learning is most profound when it is experiential. For Chemistry, this experiential learning is predominantly realized through practical work conducted in well-equipped laboratories. Practical activities are not an optional add-on but an integral component of Chemistry pedagogy. Hofstein and Lunetta (2004) posit that the laboratory is the primary venue where abstract chemical concepts—such as mole concept, chemical bonding, reaction rates, and stoichiometry—are transformed into tangible, observable phenomena. It is where students can witness the colour change of a titration endpoint, feel the exothermic release of energy from a reaction, or observe the precipitation of a solid. This process of concretization is crucial for developing a deep, conceptual understanding that moves beyond rote memorization of formulas and equations.

Furthermore, the Chemistry laboratory serves as a training ground for essential scientific and life skills. It is where students develop manipulative skills—the dexterity to handle burettes, pipettes, and other delicate apparatus with precision. It fosters scientific inquiry and critical thinking by engaging students in the processes of hypothesis formulation, experimental design, careful observation, data recording, analysis, and interpretation. Through guided and open-ended investigations, students cultivate problem-solving abilities, learn to troubleshoot failed experiments, and develop a sense of perseverance. The collaborative nature of most laboratory work also nurtures teamwork, communication, and a sense of shared responsibility. Importantly, the laboratory is the ideal environment to inculcate a culture of safety, teaching students how to handle hazardous chemicals responsibly, use personal protective equipment, and respond to emergencies, thereby preparing them for professional scientific environments.

The recognition of these immense benefits is reflected in the official curricula and examination syllabi. The West African Examinations Council (WAEC) and the National Examinations Council (NECO) curricula for Chemistry explicitly mandate a wide range of practical activities and experiments that students must be exposed to, with a significant portion of the final examination

score (typically 20-30%) allocated to practical work (West African Examinations Council [WAEC], 2023). This policy framework presupposes that schools possess the basic infrastructure, equipment, and reagents to implement these curricular demands. However, a profound and persistent chasm exists between this policy ideal and the stark reality on the ground in a vast number of Nigerian public secondary schools.

The Nigerian educational landscape, particularly in the public sector, is plagued by chronic underfunding, poor infrastructure, and inadequate resource provision. This crisis is acutely felt in the domain of science laboratories. Numerous national and regional studies have highlighted the deplorable state of laboratory facilities across the country. The situation is often more severe in rural and semi-urban areas, which suffer from systemic neglect and a disproportionate allocation of resources compared to their urban counterparts. Omoku, a town in the Ogba/Egbema/Ndoni Local Government Area (ONELGA) of Rivers State, epitomizes this paradox. As an oil-rich community, it contributes significantly to the national economy, yet its educational institutions, particularly public secondary schools, remain critically under-resourced. This "resource curse" in the educational sector creates a cycle where the potential human capital needed to manage and benefit from the local natural resources is underdeveloped.

Recent audits and independent research in Rivers State paint a grim picture of infrastructural decay in public schools (Rivers State Ministry of Education, 2021; Eze and Onuoha, 2023). This systemic failure directly compromises the quality and safety of science instruction. The three public senior secondary schools in Omoku.

This acute shortage of laboratory resources is a national crisis that severely constrains effective science teaching. This aligns with the long-standing findings of authors like Ogunleye (2009) and Okebukola (2017), who have consistently identified inadequate laboratory facilities as a primary constraint to effective science teaching in Nigeria. Studies such as that by Babatunde and Akinbobola (2015) have shown that the lack of essential resources forces the teaching of practical concepts into a theoretical framework.

This context raises a critical question: of what value is having a relatively higher number of qualified teachers if the fundamental tools for them to execute their professional duties effectively are absent?

The consequence of this practical deprivation is a cascade of negative educational outcomes. Students are forced to learn Chemistry as a collection of abstract, often confusing, facts to be memorized for examinations. This rote learning approach kills curiosity, diminishes motivation, and leads to a poor conceptual understanding of the subject. The ultimate manifestation of this failure is chronic underperformance in internal and external Chemistry examinations, particularly in the practical papers. More alarmingly, it stifles the development of the very scientific literacy and technical skills that the nation desperately needs for its development, potentially contributing to a "skills gap" in the domestic workforce and perpetuating dependence on foreign expertise. The link between laboratory experience and improved learning outcomes is well-established in science education literature (e.g., Hofstein & Lunetta, 2004; Abrahams and Millar, 2008). In the Nigerian context, researchers have consistently reported a positive relationship between resource availability,

practical engagement, and student achievement (e.g., Okebukola, 2005; Udo, 2011). This is supported by earlier findings such as those of Adeyemo (2010), who concluded that students with access to laboratory resources demonstrated superior conceptual understanding and practical skills compared to those without. This body of evidence underscores that without a functional laboratory, the goal of producing scientifically literate graduates remains elusive.

Therefore, this study is situated within this critical nexus of policy, resource allocation, pedagogical practice, and learning outcomes. It seeks to move beyond generalized assertions about laboratory inadequacy to provide a fine-grained, empirical analysis of the specific situation in Omoku's public senior secondary schools. By systematically assessing the availability and utilization of Chemistry laboratory facilities, examining the constraining factors, and investigating the perceived impact on students' understanding, this research aims to generate context-specific data that can inform targeted interventions and policy recommendations. It is a step towards bridging the gap between the intended Chemistry curriculum and the enacted learning experience for students in this unique and important part of Rivers State.

Statement of the Problem

Persistent deficiencies in Chemistry education in Nigerian public secondary schools are linked to inadequate practical exposure, as consistently noted in WAEC Chief Examiners' reports. This inadequacy potentially leads to rote learning, poor conceptual understanding, low student motivation, and ultimately, underperformance in Chemistry examinations and a lack of requisite skills for further studies or the workforce. This study addresses the lack of empirical data on how laboratory availability and utilization affect Chemistry education in Omoku's public schools.

Purpose of the Study

The primary purpose of this study is to assess the availability and utilization of laboratory facilities for teaching Chemistry in the public senior secondary schools in Omoku. Specifically, the study aimed to:

1. Assess the availability of Chemistry laboratory facilities in Omoku public senior secondary schools.
2. Examine the utilization of available Chemistry laboratory facilities in Omoku public senior secondary schools.
3. Examine the factors influencing the utilization of laboratory facilities in these schools.
4. Investigate the influence of laboratory facilities usage on students' understanding of Chemistry concepts.

Research Questions

The following research questions guided the study:

1. What laboratory facilities (equipment, apparatus, reagents, infrastructure) are available for Chemistry instruction in public senior secondary schools in Omoku?
2. To what extent are available facilities utilized for practical Chemistry instruction?

3. What factors constrain the effective utilization of laboratory facilities in teaching Chemistry in these schools?
4. How does Chemistry laboratory facilities usage influence students' understanding of Chemistry concepts in public senior secondary schools in Omoku?

Methodology

This study adopts a descriptive survey research design. The survey design is appropriate as it allows for the systematic collection of data from a representative sample of a population to describe, compare, and analyze their characteristics, attitudes, or opinions regarding the phenomenon under study. This study is conducted in Omoku, the administrative headquarters of Ogba/Egbema/Ndoni Local Government Area (ONELGA) in Rivers State, Nigeria.

The target population comprises all Chemistry teachers and all Senior Secondary Two (SS2) students in the three public senior secondary schools in Omoku. The choice of SS2 students is informed by the fact that they have completed at least one year of senior secondary Chemistry and are familiar with laboratory activities as prescribed in the curriculum. Specifically, the population consists of all Chemistry teachers in the three schools. Thus, the total study population is 305 comprising of 5 chemistry teachers and 300 SS 2 chemistry students.

A combination of sampling techniques is employed to select participants for the study. For teachers, a census sampling technique is used, whereby all five (5) Chemistry teachers across the three schools are included in the sample. This decision is based on the small and manageable population of Chemistry teachers, and their inclusion ensures comprehensive data from all available Chemistry teachers. For students, a stratified random sampling technique is adopted. Each of the three schools constitutes a stratum, and from the register of SS2 students in each school, forty (40) students are selected using simple random sampling techniques. This yields a total student sample of one hundred and twenty (120). The overall sample size for the study is therefore one hundred and twenty-five (125) respondents (five teachers and one hundred and twenty students).

Three instruments were developed and used for data collection to ensure a comprehensive assessment aligned with the research objectives. The instruments are:

Chemistry Laboratory Facility Inventory and Functionality Assessment Checklist, Chemistry Teachers' Utilization and Constraints Questionnaire, Students' Perception and Practical Exposure Questionnaire

The face and content validity of the three instruments (CLIFAC, CTUCQ, and SPPEQ) are established through a rigorous review process. The draft instruments are developed based on extensive literature review and the conceptual framework of the study. They are then submitted to three experts in the fields of Science Education, Educational Measurement and Evaluation, and Chemistry Education from the Faculty of Education. The experts evaluate the instruments based on clarity and unambiguity, ensuring that items are clearly worded and understandable; relevance, verifying that items align with the research questions and study objectives; comprehensiveness, confirming that the instruments cover all necessary aspects of availability, utilization, constraints, and impact; and appropriateness, assessing the

suitability of the scale format and checklist structure. Feedback, corrections, and suggestions from the experts are used to modify, refine, and finalize the instruments before administration, ensuring they adequately measure the intended constructs.

The reliability of the questionnaires (CTUCQ and SPPEQ) is determined through a pilot study. The CTUCQ and SPPEQ are administered to thirty SS2 students and three Chemistry teachers in a public secondary school in a neighboring local government area that is not included in the main study sample. The data obtained from the pilot study are analyzed using Cronbach's Alpha coefficient to assess the internal consistency of the scaled items. A reliability coefficient of 0.70 was obtained, indicating that the instruments are reliable for the main study. The Chemistry Laboratory Facility Checklist (CLIFAC) is not subjected to a statistical reliability test; instead, its reliability is ensured through expert validation, which confirms that the content is comprehensive and accurately reflects required laboratory facilities, and through the use of a standardized observation protocol during the direct assessment, which minimizes subjectivity.

Prior to data collection, ethical approval and necessary permits are obtained from the Rivers State Ministry of Education and the principals of the three selected schools. For the administration of the Chemistry Laboratory Facility Checklist (CLIFAC), the researchers personally visit the Chemistry laboratory of each school. Using the validated checklist, the researchers conduct a physical inventory, systematically recording the presence, quantity, and functional state of each item. The Chemistry teachers or a

designated laboratory attendant collaborates with the researchers to provide accurate insights. For the questionnaires, the researchers administered them personally. The Chemistry Teachers' Questionnaire (CTUCQ) is distributed to all five Chemistry teachers at their respective schools. The Students' Questionnaire (SPPEQ) is administered during a pre-arranged class period to the one hundred and twenty selected SS2 students. Clear instructions are provided, and the researchers remain present to address any questions. Anonymity and confidentiality are assured to encourage honest responses, and completed questionnaires were collected immediately to ensure a high retrieval rate.

Data from the questionnaires (CTUCQ and SPPEQ) were analyzed using descriptive statistics, specifically mean and standard deviations, computed for each item to determine the average responses regarding utilization, constraining factors, and perceived impact. A criterion mean of 2.5 on the 4-point scale is adopted for interpretation: mean scores above 2.5 are interpreted as high (or positive) perception, while mean scores below 2.5 are interpreted as low (or negative) perception. Standard deviations indicate the variability of responses. No statistical tests are conducted, as the study does not formulate or test any hypotheses.

Results

Research Question 1: What laboratory facilities (equipment, apparatus, reagents, and infrastructure) are available for Chemistry instruction in public senior secondary schools in Omoku?

Table 4.1: Availability and Functionality of Apparatus and Glassware in Chemistry Laboratories

Category/Item	CGSS Omoku			CSS Omoku			MBSS Omoku		
	Avail	Qty	F/NF	Avail	Qty	F/NF	Avail	Qty	F/NF
Beakers (various sizes)	Yes	30	F	Yes	10	F	Yes	10	F
Conical flasks	Yes	31	F	Yes	9	F	Yes	7	F
Test tubes & rack	Yes	20	F	Yes	4	F	Yes	10	F
Measuring cylinders	Yes	15	F	Yes	2	F	Yes	6	F
Burettes (50 cm ³)	Yes	3	F	No	0	-	Yes	1	F
Pipettes (volumetric)	Yes	5	F	Yes	3	F	Yes	4	F
Droppers	Yes	3	F	Yes	1	F	Yes	2	F
Watch glasses	Yes	10	F	Yes	2	F	Yes	3	F
Glass rods	Yes	3	F	No	0	-	Yes	1	F
Funnels	Yes	10	F	Yes	2	F	Yes	3	F
Tripod stand & wire gauze	No	0	-	No	0	-	Yes	3	F
Bunsen burners	No	0	-	No	0	-	Yes	2	F
Spatulas	Yes	20	F	Yes	3	F	Yes	6	F
Thermometers	Yes	5	F	No	0	-	Yes	1	F
Electronic/beam balance	Yes	1	NF	No	0	-	Yes	1	F
Desiccator	No	0	-	No	0	-	No	0	-
Wash bottles	Yes	10	F	Yes	2	F	Yes	6	F
Evaporating dishes	Yes	3	F	No	0	-	No	0	-

Key: F = Functional, NF = Non-functional, Avail = Availability

Table 4.1 reveals marked disparities in the availability and functionality of apparatus and glassware across the three schools. CGSS Omoku demonstrated the highest quantity of apparatus, with 30 beakers, 31 conical flasks, and 20 test tubes, all functional. The school also possessed essential volumetric apparatus including 3 burettes and 5 pipettes, all functional. However, critical heating apparatus such as Bunsen burners and tripod stands were absent, and the electronic balance was non-functional.

CSS Omoku presented a more critical situation. The school had limited quantities of basic glassware (10 beakers, 9 conical flasks, 4 test tubes) and completely lacked burettes, glass rods,

thermometers, balances, and evaporating dishes. Furthermore, the 3 pipettes available were non-functional. Critical heating apparatus were also absent.

MBSS Omoku exhibited a mixed profile. The school possessed functional heating apparatus including 2 Bunsen burners and 3 tripod stands, along with a functional electronic balance. However, the quantities of apparatus were modest (10 beakers, 7 conical flasks, 10 test tubes), and essential items such as desiccators and evaporating dishes were absent. Notably, MBSS Omoku was the only school with functional Bunsen burners, making it potentially capable of conducting experiments requiring heating.

Table 4.2: Availability and Functionality of Reagents and Chemicals

Category/Item	CGSS Omoku			CSS Omoku			MBSS Omoku		
	Avail	Qty	State	Avail	Qty	State	Avail	Qty	State
Acids									
Hydrochloric acid (HCl)	Yes	1	F	Yes	1	F	Yes	1	F
Tetraoxosulphate (VI) acid (H ₂ SO ₄)	Yes	1	F	No	0	-	Yes	1	F
Trioxonitrate (V) acid (HNO ₃)	Yes	2	F	No	0	-	Yes	1	F
Ethanoic acid (CH ₃ COOH)	Yes	1	F	No	0	-	No	0	-
Bases									
Sodium hydroxide (NaOH)	Yes	3	F	Yes	1	E	Yes	1	F
Potassium hydroxide (KOH)	Yes	1	F	No	0	-	No	0	-
Ammonia solution (NH ₃ (aq))	Yes	2	F	No	0	-	Yes	1	F
Indicators									
Methyl orange	Yes	5	F	Yes	1	F	Yes	1	F
Phenolphthalein	Yes	3	F	No	0	-	Yes	1	F
Universal indicator	Yes	1	F	No	0	-	No	0	-
Primary Standards									
Anhydrous Na ₂ CO ₃	Yes	3	F	No	0	-	No	0	-
Hydrated oxalic acid	No	0	-	No	0	-	No	0	-
Salts (Qualitative Analysis)	Yes	15	F	Yes	3	F	Yes	3	F
Test Reagents									
Barium chloride (BaCl ₂)	Yes	5	F	Yes	1	F	Yes	1	F
Silver trioxonitrate(V) (AgNO ₃)	Yes	3	F	No	0	-	No	0	-
Lime water (Ca(OH) ₂)	Yes	2	E	No	0	-	No	0	-
Potassium permanganate (KMnO ₄)	Yes	1	F	No	0	-	No	0	-
Potassium dichromate (K ₂ Cr ₂ O ₇)	Yes	1	F	No	0	-	No	0	-
Sodium carbonate (Na ₂ CO ₃)	Yes	5	F	No	0	-	Yes	1	F

Key: F = Functional, NF = Non-functional, E = Expired

Table 4.2 reveals significant disparities in reagent availability across the three schools. CGSS Omoku demonstrated the most comprehensive reagent inventory, with functional acids (HCl, H₂SO₄, HNO₃, ethanoic acid), bases (NaOH, KOH, NH₃), three types of indicators, primary standard sodium carbonate, a diverse

range of salts, and a full complement of test reagents. This suggests that CGSS Omoku has the chemical resources to conduct both quantitative and qualitative analysis experiments prescribed in the WAEC syllabus.

CSS Omoku exhibited critical deficiencies in reagent availability. While hydrochloric acid and methyl orange were present and functional, the school lacked tetraoxosulphate (VI) acid, trioxonitrate (V) acid, ethanoic acid, potassium hydroxide, ammonia solution, phenolphthalein, universal indicator, both primary standards, silver trioxonitrate(V), lime water, potassium permanganate, potassium dichromate, and sodium carbonate. Furthermore, the available sodium hydroxide was expired. This severe shortage of reagents fundamentally compromises the school's ability to conduct any meaningful practical Chemistry instruction.

MBSS Omoku presented a mixed situation. The school possessed functional acids (HCl, H₂SO₄, HNO₃), ammonia solution, methyl orange, phenolphthalein, barium chloride, and sodium carbonate. However, the school lacked ethanoic acid, potassium hydroxide, universal indicator, both primary standards, silver trioxonitrate(V), lime water, and other test reagents. Critically, the available salts for qualitative analysis were expired. This situation allows for limited experiments but severely restricts comprehensive practical work, particularly qualitative analysis.

Table 4.3: Availability of Safety Equipment in Chemistry Laboratories

Safety Equipment	CGSS Omoku	CSS Omoku	MBSS Omoku
Goggles	Yes (4, F)	No	No
Laboratory coats	No	No	No
Fume cupboard/hood	No	No	No
Fire extinguisher	No	No	Yes (1)
Fire blanket	No	No	No
First-aid kit	No	No	No
Sand bucket	No	No	No
Eye wash station	No	No	Yes (1)

Key: F = Functional

Table 4.3 reveals a pervasive lack of safety equipment across all three schools. CGSS Omoku possessed 4 functional goggles but completely lacked laboratory coats, fume cupboards, fire extinguishers, fire blankets, first-aid kits, sand buckets, and eye wash stations. CSS Omoku had no safety equipment whatsoever. MBSS Omoku had a fire extinguisher and an eye wash station but lacked all other essential safety equipment. The absence of basic

safety infrastructure, particularly fume cupboards and first-aid kits, creates hazardous learning environments that discourage practical work and expose students to potential harm. This finding aligns with the concerns raised by Akinbobola and Ikitde (2025) regarding poor safety practices in Nigerian secondary school laboratories.

Table 4.4: Availability of Supporting Infrastructure

Infrastructure	CGSS Omoku	CSS Omoku	MBSS Omoku
Running water (tap/sink)	No	No	Yes (2, F)
Electricity supply	No	No	No
Adequate ventilation	No	No	Yes (4 windows/fans)
Laboratory workbenches	No	No	Yes (4, F)
Chemical storage cabinet	Yes (2, F)	Yes (1, F)	Yes (2, F)
Apparatus storage cupboard	Yes (1, F)	No	Yes (1, F)
Waste disposal bin Yes (1, F) No	Yes (1, F)	No	Yes (1, F)

Key: F = Functional

Table 4.4 demonstrates stark differences in supporting infrastructure. MBSS Omoku emerged as the best-equipped in terms of infrastructure, with functional running water, adequate ventilation, laboratory workbenches, chemical storage cabinets, apparatus storage, and waste disposal facilities. However, the school lacked electricity supply, which is critical for powering balances and providing adequate lighting.

CGSS Omoku and CSS Omoku both lacked running water, electricity, ventilation, and workbenches. CGSS Omoku had functional storage facilities (chemical cabinet, apparatus cupboard, waste bin), while CSS Omoku only had a chemical storage cabinet. The absence of running water in two schools is particularly debilitating, as water is essential for cleaning apparatus, conducting experiments involving cooling or dilution, and maintaining hygiene standards.

Table 4.5: Overall Laboratory Functionality Assessment

School	Overall Assessment
CGSS Omoku	Laboratory has severe deficiencies; only basic demonstrations possible
CSS Omoku	Laboratory is non-functional
MBSS Omoku	Laboratory has severe deficiencies; only basic demonstrations possible

Table 4.5 presents the researcher's overall assessment based on the comprehensive inventory. CSS Omoku was assessed as having a non-functional laboratory, unable to support any meaningful practical Chemistry instruction. Both CGSS Omoku and MBSS

Omoku were assessed as having severe deficiencies that restrict instruction to basic demonstrations, with neither school capable of conducting the full range of WAEC-prescribed practicals.

Table 4.6: Students' Mean Ratings on Availability of Laboratory Facilities

SN	Item	CGSS (N=40)	CSS (N=40)	MBSS (N=40)
		Mean	SD	Mean
1	Our school has a dedicated Chemistry laboratory	3.00	0.00	1.00
2	The laboratory has enough glassware for all students	3.00	0.00	1.00
3	The laboratory has measuring instruments (burettes, pipettes, balances)	2.00	0.00	1.00
4	There is constant water supply in the laboratory	1.00	0.00	1.00
5	There is regular electricity supply during practical sessions	1.00	0.00	1.00
6	The laboratory has safety equipment (goggles, first-aid kit, fire extinguisher)	1.00	0.00	1.00
7	Chemicals and reagents needed for experiments are always available	2.00	0.00	1.00
Grand Mean		1.86		1.00

Key: 4-point scale (1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree); Criterion Mean = 2.50

Table 4.6 presents students' perceptions of laboratory facility availability across the three schools. The grand mean for CGSS Omoku was 1.86, below the criterion mean of 2.50, indicating that students generally disagreed that adequate facilities were available. Notably, students agreed (mean 3.00) that the school had a dedicated laboratory and sufficient glassware, but disagreed regarding measuring instruments (mean 2.00), and strongly disagreed regarding water supply, electricity, and safety equipment (all mean 1.00). The standard deviation of 0.00 for most items indicates unanimous responses among students.

CSS Omoku recorded a grand mean of 1.00, the lowest possible score, indicating that students strongly disagreed with all statements about facility availability. This reflects the non-

functional state of the laboratory confirmed by the CLIFAC inventory.

MBSS Omoku recorded a grand mean of 2.00, below the criterion mean. Students agreed (mean 3.00) that the school had a dedicated laboratory and constant water supply, but disagreed regarding glassware sufficiency (mean 2.00), measuring instruments (mean 2.00), and safety equipment (mean 2.00). Students strongly disagreed regarding electricity supply (mean 1.00) and reagent availability (mean 1.00). These perceptions align with the CLIFAC findings showing MBSS Omoku had functional water but no electricity.

Research Question 2: To what extent are available facilities utilized for practical Chemistry instruction?

Table 4.7: Teachers' Mean Ratings on Utilization of Laboratory Facilities

SN	Item	CGSS Teacher (N=1)	CSS Teacher (N=1)	MBSS Teacher (N=1)
		Rating	Rating	Rating
1	I conduct hands-on practical sessions for students	3	1	1
2	Students carry out titration (volumetric analysis) experiments	2	1	1
3	Students perform qualitative analysis (salt identification) experiments	2	1	1
4	I use apparatus/reagents to demonstrate experiments	2	1	1
5	I integrate practical work into regular Chemistry lessons	3	1	1
6	Students work in small groups during practical sessions	1	1	2
7	Students are assessed on their practical skills	2	1	2
8	Available facilities adequate for WAEC required practicals	2	1	1
Mean		2.13	1.00	1.25

Key: 4-point scale (1=Never, 2=Rarely, 3=Often, 4=Very Often); Criterion Mean = 2.50

Table 4.7 reveals that only the teacher at CGSS Omoku reported any meaningful utilization of laboratory facilities, with a mean score of 2.13, still below the criterion mean of 2.50. This teacher reported conducting hands-on practical sessions and integrating practical work into regular lessons (both rated 3, "Often"), but rarely conducted titration experiments, qualitative analysis, or demonstrations (rated 2, "Rarely"), and never had students work in small groups (rated 1, "Never"). The teacher also rated the adequacy of facilities for WAEC practicals as "Rarely" (2). The teachers at CSS Omoku and MBSS Omoku both reported never utilizing laboratory facilities for any practical Chemistry

instruction, with mean scores of 1.00 and 1.25 respectively. The MBSS teacher reported rarely having students work in small groups (2) and rarely assessing practical skills (2), but never conducted hands-on sessions, titration, qualitative analysis, demonstrations, or integrated practical work into lessons. The CSS teacher reported never utilizing any laboratory facilities across all items. These findings indicate that the availability of facilities directly constrains utilization, consistent with the CLIFAC findings showing CSS laboratory is non-functional and MBSS has severe deficiencies.

Table 4.8: Students' Mean Ratings on Exposure to Practical Chemistry Activities

SN	Item	CGSS (N=40)	CSS (N=40)	MBSS (N=40)
		Mean	SD	Mean
1	I perform Chemistry practicals in the laboratory	2.00	0.00	1.00
2	I work in small groups during practical sessions	2.00	0.00	1.00
3	I have carried out titration experiments	2.00	0.00	1.00
4	I have carried out qualitative analysis	2.00	0.00	1.00
5	I have used Bunsen burner and heating apparatus	2.00	0.00	1.00
6	My teacher demonstrates experiments when we cannot perform them	3.00	0.00	2.00
7	I have access to apparatus and chemicals when needed	3.00	0.00	1.00
Grand Mean		2.29		1.14

Key: 4-point scale (1=Never, 2=Rarely, 3=Often, 4=Very Often); Criterion Mean = 2.50

Table 4.8 presents students' reports on their exposure to practical Chemistry activities. CGSS Omoku students reported the highest level of exposure with a grand mean of 2.29, still below the criterion mean of 2.50. Students reported that their teacher often demonstrates experiments when they cannot perform them (mean 3.00) and that they have access to apparatus and chemicals when

needed (mean 3.00). However, students reported only rarely performing practicals themselves, working in small groups, carrying out titration, carrying out qualitative analysis, or using heating apparatus (all mean 2.00). This indicates that practical instruction at CGSS is predominantly teacher demonstration rather than hands-on student participation.

CSS Omoku students reported very low exposure to practical activities, with a grand mean of 1.14. Students reported never performing practicals, working in groups, carrying out titration, carrying out qualitative analysis, or using heating apparatus (all mean 1.00). They reported that teachers rarely demonstrate experiments (mean 2.00) and that they never have access to apparatus and chemicals (mean 1.00). This reflects the non-functional laboratory and teacher reports of no practical activities.

MBSS Omoku students reported similarly low exposure, with a grand mean of 1.29. Students reported never performing practicals,

carrying out titration or qualitative analysis, having access to apparatus, or having teacher demonstrations (all mean 1.00). They reported rarely working in small groups or using heating apparatus (mean 2.00). This aligns with the teacher's report of no practical activities and the severe deficiencies noted in the laboratory inventory.

Research Question 3: What factors constrain the effective utilization of laboratory facilities in teaching Chemistry in these schools?

Table 4.9: Teachers' Mean Ratings on Factors Constraining Utilization of Laboratory Facilities

SN	Constraint Factor	CGSSTeacher	CSS Teacher	MBSS Teacher
		Rating	Rating	Rating
1	Inadequate number of functional apparatus	4	4	4
2	Insufficient or expired reagents/chemicals	2	4	4
3	Lack of constant water supply	4	4	1
4	Lack of reliable electricity	4	4	4
5	Overcrowded classes	4	4	2
6	Inadequate time allocated for practicals	2	4	2
7	Poor laboratory infrastructure (workbenches, ventilation, storage)	4	4	2
8	Lack of safety equipment	2	4	3
9	Lack of laboratory assistant/technician	4	1	3
10	Pressure to complete theoretical syllabus	2	1	2
11	Insufficient funding for laboratory materials	4	4	4
Mean		3.27	3.45	3.00

Key: 4-point scale (1=Not a constraint, 2=Slight constraint, 3=Moderate constraint, 4=Severe constraint); Criterion Mean = 2.50

Table 4.9 reveals that all three teachers perceived the constraints as severe or moderate, with mean scores above the criterion mean of 2.50. The CSS teacher recorded the highest mean (3.45), followed by CGSS teacher (3.27), and MBSS teacher (3.00).

For CSS Omoku, the teacher rated eight factors as severe constraints (4): inadequate apparatus, insufficient/expired reagents, lack of water, lack of electricity, overcrowded classes, inadequate time, poor infrastructure, lack of safety equipment, and insufficient funding. Only lack of laboratory assistant and pressure to complete syllabus were rated as slight or no constraint. This comprehensive set of constraints explains the non-functional laboratory status.

For CGSS Omoku, the teacher rated seven factors as severe constraints (4): inadequate apparatus, lack of water, lack of electricity, overcrowded classes, poor infrastructure, lack of laboratory assistant, and insufficient funding. Insufficient/expired reagents were rated as slight constraint (2), suggesting that reagent availability at CGSS was less problematic than apparatus and infrastructure. However, the absence of water, electricity, and basic infrastructure emerged as critical barriers.

For MBSS Omoku, the teacher rated insufficient/expired reagents, lack of electricity, and insufficient funding as severe constraints (4). Lack of safety equipment and lack of laboratory assistant were rated as moderate constraints (3). Inadequate apparatus was rated as moderate (3), while overcrowded classes, poor infrastructure, and inadequate time were rated as slight constraints (2). Water supply was rated as no constraint (1), consistent with the CLIFAC finding that MBSS has functional water.

The consistent rating of insufficient funding as a severe constraint (4) across all three schools underscores the systemic nature of resource deprivation. This finding aligns with the literature documenting chronic underfunding as a primary barrier to effective science education in Nigerian public schools (Ogunleye, 2009; Adewumi & Okafor, 2024).

Research Question 4: How does Chemistry laboratory facilities usage influence students' understanding of Chemistry concepts?

Table 4.10: Teachers' Mean Ratings on Influence of Laboratory Usage on Students' Understanding

SN	Item	CGSSTeacher	CSS Teacher	MBSS Teacher
		Rating	Rating	Rating
1	Laboratory work helps students understand abstract Chemistry concepts better	4	4	4
2	Students who regularly perform practicals perform better in theory examinations	4	4	4
3	Practical experience improves students' ability to answer WAEC practical questions	4	4	4
4	Students develop greater interest in Chemistry when they use the laboratory	4	4	4
5	Lack of laboratory facilities makes it difficult for students to grasp key topics like mole concept, titration, and qualitative analysis	4	4	4
6	Students' manipulative and problem-solving skills are enhanced through hands-on laboratory work	4	4	4
	Mean	4.00	4.00	4.00

Key: 4-point scale (1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree); Criterion Mean = 2.50

Table 4.10 reveals unanimous agreement among all three Chemistry teachers across all items, with each teacher rating every item as 4 (Strongly Agree). The mean score of 4.00 for each school indicates that teachers strongly affirm the positive influence of laboratory work on students' conceptual understanding, academic performance, WAEC practical ability, interest in Chemistry, and manipulative skills development. Conversely, teachers strongly

agree that the absence of laboratory facilities impedes students' grasp of abstract concepts such as mole concept, titration, and qualitative analysis. This unanimous perception underscores the pedagogical importance of laboratory work, consistent with the theoretical frameworks of constructivism and experiential learning discussed in Chapter Two.

Table 4.11: Students' Mean Ratings on Influence of Laboratory Usage on Understanding

SN	Item	CGSS (N=40)	CSS (N=40)	MBSS (N=40)
		Mean	SD	Mean
1	Practical work helps me understand topics like acids and bases, mole concept, and chemical reactions	3.00	0.00	2.00
2	I can remember Chemistry topics better when I have done the experiment myself	3.00	0.00	2.00
3	Laboratory sessions make Chemistry more interesting	3.00	0.00	2.00
4	I feel confident in handling laboratory apparatus and carrying out experiments	3.00	0.00	1.00
5	If we do not use the laboratory, I find it hard to understand some Chemistry concepts	3.00	0.00	3.00
6	I believe practical work will help me perform better in my WAEC Chemistry examination	3.00	0.00	3.00
	Grand Mean	3.00		2.17

Key: 4-point scale (1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree); Criterion Mean = 2.50

Table 4.11 reveals varying perceptions among students across the three schools. CGSS Omoku students recorded the highest grand mean of 3.00, above the criterion mean, indicating strong agreement that laboratory work enhances their understanding. Students agreed (mean 3.00) that practical work helps them understand abstract concepts, improves retention, makes Chemistry more interesting, builds confidence, and would improve WAEC

performance. They also agreed (mean 3.00) that lack of laboratory use makes understanding difficult. The standard deviation of 0.00 indicates unanimous agreement among respondents.

CSS Omoku students recorded a grand mean of 2.17, below the criterion mean. Students agreed (mean 3.00) that lack of laboratory use makes understanding difficult and that practical work would improve WAEC performance, but disagreed (mean 2.00) that

practical work helps understanding, improves retention, or makes Chemistry more interesting. They strongly disagreed (mean 1.00) that they feel confident handling apparatus. This pattern reflects students' awareness of the value of laboratory work despite their limited exposure, coupled with low self-efficacy due to lack of practical experience.

MBSS Omoku students recorded a grand mean of 2.33, also below the criterion mean. Students agreed (mean 3.00) that laboratory sessions make Chemistry more interesting, that lack of laboratory use makes understanding difficult, and that practical work would improve WAEC performance. However, they disagreed (mean 2.00) that practical work helps understanding or improves retention, and strongly disagreed (mean 1.00) that they feel confident handling apparatus. This pattern is similar to CSS, indicating recognition of the value of practical work but low self-efficacy due to minimal hands-on experience.

The disparity between CGSS students (grand mean 3.00) and students at CSS and MBSS (2.17 and 2.33) is notable. This difference likely reflects CGSS students' greater exposure to teacher demonstrations and occasional practical sessions, which, while not optimal, still provides some experiential basis for understanding. This finding aligns with Bandura's (1997) theory of self-efficacy, which identifies mastery experiences as the most potent source of confidence. Students at CSS and MBSS, who have had virtually no hands-on laboratory experience, exhibit low confidence in handling apparatus, consistent with the theoretical expectation.

Discussion of Findings

Availability of Chemistry Laboratory Facilities

The findings from the Chemistry Laboratory Facility Inventory and Functionality Assessment Checklist (CLIFAC) revealed a stark and disturbing picture of laboratory facility availability across the three public senior secondary schools in Omoku. Only one school (CGSS Omoku) had a dedicated laboratory space with a relatively comprehensive inventory of glassware, reagents, and apparatus, albeit with critical deficiencies in heating apparatus, water supply, electricity, and safety equipment. The second school (MBSS Omoku) possessed some infrastructure (water, workbenches, ventilation) and limited apparatus, but lacked essential reagents and safety equipment. The third school (CSS Omoku) had a non-functional laboratory with severe shortages across all categories of facilities.

These findings are consistent with the long-standing observations of Nigerian science education researchers. Ogunleye (2009) and Okebukola (2017) identified inadequate laboratory facilities as a primary constraint to effective science teaching in Nigeria. The present study confirms that this problem persists and is particularly acute in semi-urban areas like Omoku. The finding that CSS Omoku, despite having three Chemistry teachers, has a non-functional laboratory powerfully illustrates the point made in the introduction: staffing is a necessary but insufficient condition for quality Chemistry education. The teachers at CSS Omoku are rendered ineffective by the absence of the fundamental tools required to execute their professional duties.

The chronic underfunding identified in the literature (Adewumi and Okafor, 2024; Nwankwo, 2019) is evident in the state of these laboratories. The absence of basic utilities such as running water and electricity in two of the three schools, the lack of safety

equipment across all schools, and the expired reagents at MBSS and CSS all point to systemic neglect and inadequate recurrent expenditure for consumables and maintenance. This aligns with the findings of Udo and Ndem (2020) in Akwa Ibom State, who reported that only about 30% of essential equipment items were available in secondary school laboratories, and less than 50% of those were functional.

Utilization of Available Laboratory Facilities

The findings on utilization revealed that practical Chemistry instruction is either severely limited or entirely absent across the three schools. The teacher at CGSS Omoku reported conducting hands-on practical sessions and integrating practical work into lessons "often," but only rarely conducted titration or qualitative analysis experiments. Students at CGSS confirmed that teacher demonstrations were the predominant mode of practical instruction, with limited opportunities for hands-on student participation. At CSS and MBSS, both teachers and students reported no hands-on practical activities whatsoever.

These findings align with the pattern identified by Babatunde and Akinbobola (2015), who found that teacher demonstration and "theoretical practical" modes were associated with lower student performance compared to hands-on student-centered practicals.

Factors Constraining Effective Utilization

All three teachers identified insufficient funding as a severe constraint, reflecting the systemic underfunding of science education in Nigerian public schools documented by Adewumi and Okafor (2024) and Ogunleye (2009). The absence of functional apparatus, insufficient reagents, and lack of infrastructure all trace back to inadequate and poorly managed funding.

These findings resonate with the empirical literature. Ibe and Nwazor (2022) identified large class sizes, absolute lack of reagents, frequent power outages, and inadequate teacher training as the most severe constraints in rural Anambra State. Similarly, Mbacho and Ndirangu (2017) found that overcrowded laboratories were a more immediate barrier than resource scarcity in Kenyan schools. The present study confirms that these constraints are equally severe in Omoku.

Influence of Laboratory Facilities Usage on Students' Understanding

The findings on the influence of laboratory usage on students' understanding revealed unanimous agreement among teachers that laboratory work is essential for conceptual understanding, academic performance, interest, and skill development. Teachers at all three schools strongly agreed that laboratory work helps students understand abstract Chemistry concepts, improves performance in theory and practical examinations, develops interest, enhances manipulative skills, and that lack of facilities impedes grasp of key topics like mole concept, titration, and qualitative analysis.

These findings are consistent with the extensive literature linking laboratory experience to improved learning outcomes. Nja et al. (2023) found that students from schools with functional labs significantly outperformed their peers on tests of conceptual understanding and science process skills. Eze and Onuoha (2023) reported a significant positive correlation between laboratory facility adequacy and Chemistry achievement in Rivers State. The present study provides complementary evidence at the perceptual

level, showing that teachers and students recognize the importance of laboratory work even when it is unavailable.

Conclusion

Based on the findings of this study, the following conclusions are drawn:

The study concludes that Chemistry laboratory facilities in public senior secondary schools in Omoku are grossly inadequate. The study further concludes that the effective utilization of laboratory facilities is constrained by a complex interplay of factors operating at systemic, institutional, and individual levels. Chronic underfunding, inadequate functional apparatus, insufficient or expired reagents, lack of basic utilities (water and electricity), overcrowded classes, poor infrastructure, absence of safety equipment, lack of laboratory assistants, and pressure to complete theoretical syllabi collectively create barriers that prevent effective practical instruction. These constraints vary across schools but collectively constitute a formidable obstacle to quality Chemistry education.

The study concludes that the lack of functional laboratory facilities and the consequent absence of hands-on practical experience profoundly affects students' understanding of Chemistry concepts. Teachers unanimously affirm that laboratory work is essential for conceptual understanding, academic performance, interest development, and skill acquisition.

The study ultimately concludes that the state of Chemistry laboratory facilities in Omoku's public secondary schools represents a crisis in science education that requires urgent and sustained intervention. The current situation violates the principles of constructivist and experiential learning theories that underpin effective science pedagogy, deprives students of essential learning experiences, undermines teacher effectiveness, and perpetuates educational inequity. Without functional laboratories, the goals of Chemistry education—to produce scientifically literate citizens equipped with the practical skills and conceptual understanding needed for national development—remain unattainable.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

1. The State Ministry of Education should immediately initiate an emergency laboratory rehabilitation program targeting the three schools in Omoku.
2. The Ministry of Education should establish a mandatory annual laboratory audit system using a standardized checklist based on WAEC requirements.
3. Given the high cost and perishability of reagents, the Ministry of Education should establish a zonal reagent revolving fund for clusters of schools in ONELGA.
4. The Ministry of Education should issue a directive mandating that all public secondary schools with science laboratories must have basic safety equipment, including goggles, laboratory coats, fire extinguishers, first-aid kits, and fume cupboards for chemistry laboratories. Compliance should be verified during laboratory audits, and non-compliance should result in withholding of grants or other sanctions.

5. The Ministry of Education should employ qualified laboratory assistants or technicians for all public secondary schools offering Chemistry at senior secondary level. These support staff would assist with laboratory preparation, maintenance, inventory management, and safety supervision, alleviating the burden on Chemistry teachers.
6. School principals should prioritize Chemistry practicals in the school timetable, allocating uninterrupted double periods for laboratory sessions.
7. Principals should leverage the resources of Omoku as an oil-producing community by actively seeking corporate social responsibility (CSR) partnerships with oil and gas companies operating in the area.
8. Principals should work with PTAs to mobilize funds for laboratory improvements, particularly for consumable reagents that require regular replenishment. PTAs should be educated on the importance of laboratory work and involved in monitoring laboratory resource utilization and maintenance.
9. Principals should prioritize the repair and maintenance of existing infrastructure, particularly water systems, electrical fittings, and storage cabinets. A preventive maintenance schedule should be established to ensure equipment remains functional.

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