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EFFECT OF GUIDED INQUIRY-BASED STRATEGY ON SENIOR SECONDARY TWO STUDENTS' PERFORMANCE IN PRACTICAL CHEMISTRY IN NASARAWA EGGON LOCAL GOVERNMENT AREA, NASARAWA STATE, NIGERIA

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ABSTRACT

This study examined the effect of Guided Inquiry-Based Strategy (GIBS) on Senior Secondary Two (SSII) students' performance in practical Chemistry in Nasarawa Eggon Local Government Area, Nasarawa State, Nigeria. A quasi-experimental, non-equivalent control group design was adopted. The population comprised 1,843 SSII Chemistry students in 32 public secondary schools. A sample of 61 students (34 males and 27 females) was selected from two schools using purposive and simple random sampling techniques. The experimental and control groups consisted of 31 and 30 students, respectively. Data were collected using a 50-item Quantitative Performance Test (QPT), covering masses, moles, volumes, concentrations and percentages. The instrument had a reliability coefficient of 0.70 using the split-half method. The treatment lasted seven weeks. Two research questions and two null hypotheses guided the study. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) tested the hypotheses at the 0.05 significance level. Results showed that the experimental group outperformed the control group (62.90 versus 53.60). The difference was statistically significant, $F(1, 58) = 16.202$, $p < .001$, partial $\eta^2 = .218$. Female students also outperformed males within the experimental group (66.00 versus 60.66), with a statistically significant gender difference, $F(1, 28) = 9.262$, $p = .005$, partial $\eta^2 = .224$. The study concluded that GIBS improved students' practical Chemistry performance, with females recording higher scores. Chemistry teachers were therefore encouraged to adopt GIBS, particularly when teaching quantitative analysis.

Keywords: inquiry-based learning, volumetric analysis, quasi-experiment, secondary school Chemistry, and Nasarawa State

Introduction

Chemistry is the branch of science concerned with the composition, properties, transformations, and interactions of matter. Its principles are applied in many areas of human endeavour, including medicine, pharmacy, engineering, agriculture, food science, environmental protection, and other aspects of human and national development (Igboanugo, 2023). In Nigeria, Chemistry and Chemistry education contribute to industrial development, food production, technological advancement, and the preparation of skilled manpower for science- and technology-related professions (Audu et al., 2023). As a practical science, Chemistry requires students to develop both conceptual understanding and practical skills through hands-on and minds-on activities (Seery et al., 2024). Practical Chemistry involves laboratory techniques, safety procedures, experimental design, data collection, observation, measurement, and qualitative and quantitative analysis. These activities help students to develop critical thinking, problem-solving ability, analytical reasoning, and scientific process skills (Elvira et al., 2023). Quantitative analysis is particularly important because it involves determining the amount or concentration of substances using appropriate measurements and standard solutions. It is also an important part of Chemistry in school and in industry (Fatma, 2021).

Despite the importance of practical Chemistry, students' performance at the senior secondary school level has remained unsatisfactory in Nigeria, including Nasarawa Eggon Local Government Area of Nasarawa State (Musa et al., 2022). Practical Chemistry accounts for a substantial proportion of students' Chemistry assessment in the West African Senior School Certificate Examination (WASSCE), making competence in practical activities important for overall performance in the subject (WAEC, 2023). The WAEC Chief Examiners' reports have identified weaknesses in students' mathematical skills, titration measurements, and the appropriate use of significant figures (WAEC, 2023). These difficulties have been linked to instructional practices, teacher-related factors, inadequate laboratory resources, assessment practices, and other student-related factors (Ogunleye et al., 2022).

One possible explanation for the continued poor performance is the reliance on teacher-centred instructional approaches. Demonstration and lecture methods can be useful when introducing information or showing students how a procedure is performed. However, when they are used excessively, students may have limited opportunities to take an active role in practical activities. Inquiry-based and hands-on approaches, on the other hand, allow students to participate directly in experimentation, observation, data collection, analysis, and explanation (Abrahams & Reiss, 2017). Guided Inquiry-Based Strategy (GIBS) is associated with the constructivist view of learning, which considers learning as an active process in which students develop understanding through interaction with materials, experiences, and ideas, with appropriate support from the teacher (Pedaste et al., 2015). In guided inquiry, the teacher does not leave students to investigate entirely on their own. Rather, the teacher provides suitable questions, materials, instructions, and other forms of support while students participate actively in observation, investigation, data collection, analysis, explanation, and drawing conclusions from evidence (Domenici, 2022). This type of structured participation can help students develop scientific reasoning, critical thinking, problem-solving skills, and scientific process skills (Sadeh & Zion, 2019).

A number of empirical studies have reported positive outcomes associated with inquiry-oriented instruction in science. Adewumi and Adejoke (2023), for example, reported that two instructional strategies improved students' science process skills in Biology. Similarly, Apeadido et al. (2024) found that structured practical lessons based on guided inquiry were associated with

improved student achievement. Akindola et al. (2023) reported that students who were taught practical Chemistry using guided inquiry performed significantly better than those taught using other instructional approaches. Ajayi and Olatunbosun (2021) also reported significant improvement in students' Chemistry achievement following the use of guided inquiry. Evidence from studies focusing specifically on practical Chemistry further supports the usefulness of guided inquiry. Abbey-Kalio (2019) found that students taught practical Chemistry through guided inquiry performed significantly better than those taught using the conventional demonstration method, particularly in acid-base titration and volumetric analysis. Uzezi and Zainab (2017) similarly reported that guided-inquiry laboratory experiments improved students' achievement in volumetric analysis compared with traditional teaching. Ojelade et al. (2026) also reported significant improvement in students' Chemistry achievement following the use of guided inquiry-based instruction. In Rwanda, Dushimimana and Mugabo (2022) found that inquiry-based teaching improved students' Chemistry performance and was also associated with more positive attitudes towards the subject.

Gender has also received attention in studies of students' performance in Chemistry. Although female enrolment in Nigerian secondary education has moved towards parity with male enrolment (Federal Ministry of Education, 2021), differences in participation and access to science-learning opportunities have continued to be reported (UNICEF, 2020). Such differences may be related to unequal access to hands-on activities, previous exposure to science experiences, and socio-cultural expectations (Adoga, 2023). However, findings on gender and Chemistry achievement have not been consistent. For instance, Ajayi and Ogbeba (2017) reported higher achievement among male students in practical Chemistry, whereas Ogunyemi and Bamidele (2019) found no significant gender difference when effective instructional strategies were used. Jack and Gisum (2024) also reported no significant gender difference under problem-based learning, while Ojo and Tijani (2025) and Shawai et al. (2022) reported gender variations under different inquiry approaches and study conditions. Studies specifically involving guided inquiry in Chemistry have largely reported no gender difference. Jack and Suleiman (2019) reported no significant difference between male and female students' Chemistry achievement when Guided-Inquiry and Concept Mapping instructional strategies were used among SSII students in Jalingo Metropolis, Taraba State. Jack and Suleiman (2017) also found no significant gender effect on students' achievement in volumetric analysis following guided-inquiry laboratory experiments. Likewise, Umanah and Babayemi (2024) reported no significant difference between male and female students' performance when peer-led and teacher-led guided inquiry approaches were used in teaching stoichiometry.

Further evidence is provided by Okpala et al. (2025), who investigated guided inquiry-based learning among 240 SSII Chemistry students in six public secondary schools in Enugu State. Their study found no significant interaction between teaching method and gender on students' Chemistry achievement. Umahaba et al. (2026) similarly reported no significant difference between male and female SSII students taught Organic Chemistry using Process-Oriented Guided Inquiry Learning Strategy (POGILS) in Kwami Local Government Area of Gombe State. These findings suggest that guided inquiry can provide opportunities for both male and female students to participate actively in Chemistry learning. However, some studies have reported different results. Abbey-Kalio (2019) found higher mean achievement among male students than female students in practical Chemistry under guided inquiry. Amadi and Okeke (2019), on the other hand, reported a significant difference in Chemistry achievement in favour of female students following instruction using the Guided Inquiry Teaching Method. These

differences suggest that gender outcomes under guided inquiry may depend on factors such as the instructional context, Chemistry content, location, sample characteristics, and manner of implementation. Thus, although guided inquiry creates opportunities for active participation, existing evidence does not show a uniform pattern of gender differences across all settings.

The literature reviewed indicates that guided inquiry has the potential to improve students' achievement in Chemistry and practical Chemistry. However, findings relating to gender remain mixed. More importantly, there is limited evidence on the effect of Guided Inquiry-Based Strategy on SSII students' performance in practical Chemistry, particularly quantitative analysis, in Nasarawa Eggon Local Government Area of Nasarawa State. This study therefore investigated the effect of Guided Inquiry-Based Strategy on SSII students' performance in practical Chemistry and examined whether students' performance differed by gender within the experimental group.

Statement of the problem

Chemistry plays a vital role in technological advancement and socio-economic development by equipping students with the scientific knowledge and skills required for careers in health, industry, engineering, and other related fields (Adeyemi & Ajiboye, 2022). Recognising its importance, the Nigerian government and relevant professional bodies, including the Science Teachers Association of Nigeria (STAN), have initiated measures to improve Chemistry teaching and learning. However, effective implementation of the Chemistry curriculum remains challenged by inadequate instructional resources and difficulties in curriculum delivery in Nigerian secondary schools (Olubunmi & Aarinola, 2022). Despite these efforts, students continue to experience difficulties in understanding fundamental Chemistry concepts, particularly in qualitative and quantitative analysis, which contribute to their poor performance in practical Chemistry (Uzezi & Zainab, 2017). Reports of the West African Examinations Council (WAEC, 2023) have also highlighted students' weaknesses in practical Chemistry, particularly in volumetric analysis, including difficulties with accurate titration readings, correct use of apparatus, observation, calculations and appropriate recording of experimental results. The problem is particularly evident in Nasarawa Eggon, where examination records indicate persistent weaknesses in areas such as mathematical calculations and accurate titration measurement. Credit-pass rates recorded between 2021 and 2025 ranged from 37.3% to 49.7% in WAEC, 41.6% to 57.6% in NECO, and 49.8% to 62.6% in NABTEB (Nasarawa Eggon & Mada Station Area Education Offices, 2025). These results suggest that a considerable proportion of students may not be acquiring the level of practical Chemistry competence expected at the senior secondary school level. One of the issues that may contribute to this problem is the continued reliance on teacher-centred demonstration methods, which may restrict students' active involvement in practical activities (Abrahams & Reiss, 2017). When students mainly observe teachers performing experiments rather than actively engaging in them, they may have fewer opportunities to connect practical experiences with the underlying Chemistry concepts. Practical learning requires both hands-on and minds-on engagement, and laboratory activities can provide such opportunities when appropriately organised (Hofstein & Kind, 2018).

The problem therefore raises the need to consider instructional approaches that can involve students more directly in the learning process. Guided Inquiry-Based Strategy provides one possible approach because it allows students to investigate practical problems while receiving appropriate guidance from the teacher (Pedaste et al., 2015). Although evidence from previous studies suggests that guided inquiry can improve Chemistry achievement, its application in practical Chemistry in Nasarawa Eggon remains limited. There is therefore a need

for evidence from the local context. Gender also remains an issue of interest because previous studies have produced different findings concerning male and female students' performance in Chemistry. While some studies have reported higher performance among male students, others have found no significant difference or have reported higher performance among female students (Ajayi & Ogbeba, 2017; Ogunyemi & Bamidele, 2019). These differences make it necessary to examine whether male and female students respond differently to guided inquiry-based practical Chemistry instruction. Against this background, the problem addressed by this study is the continued unsatisfactory performance of SSII students in practical Chemistry and the limited evidence concerning the effectiveness of Guided Inquiry-Based Strategy in addressing this problem in Nasarawa Eggon Local Government Area of Nasarawa State. The purpose of the study was therefore to determine the effect of Guided Inquiry-Based Strategy on SS II students' performance in quantitative analysis and to find out whether the effect differs between male and female students.

Research questions

1. What difference exists in the pre-test and post-test performance mean score of senior secondary two students in practical Chemistry in the experimental and control group?
2. What difference exists in the pre-test and post-test performance mean score of senior secondary two students in practical Chemistry in the experimental group based on gender?

Hypotheses

1. There is no significant difference in the pre-test and post-test practical Chemistry performance mean scores of senior secondary two students between the experimental and control groups.
2. There is no significant difference in the pre-test and post-test performance mean score of SSII students in the experimental group based on gender.

Methodology

This study adopted a quasi-experimental research design involving a non-randomised pre-test and post-test control-group approach. The design was considered appropriate because intact school classes were used without disrupting the normal school organisation, while still allowing for a meaningful comparison between an experimental group and a control group. The targeted population of the study comprised all Senior Secondary Two (SS II) Chemistry students in Nasarawa Eggon Local Government Area of Nasarawa State, with a total population of 1,843 students across 32 public senior secondary schools during the 2025/2026 academic session. The choice of Nasarawa Eggon Local Government Area was based on the persistent underperformance of students in Chemistry in the West African Senior School Certificate Examination (WASSCE) over the years. The selection of SS II students was considered appropriate because they had one academic year remaining before sitting for external examinations such as WAEC, NECO and NABTEB, and therefore had sufficient time to benefit from the instructional intervention. Furthermore, the students had acquired the foundational Chemistry knowledge and mathematical skills required to participate effectively in practical Chemistry activities involving quantitative analysis. From the population, a sample of 61 SS II students, comprising 34 males and 27 females, was selected from two co-educational public senior secondary schools using purposive and simple random sampling techniques. The two schools were selected based on the availability of functional and adequately equipped Chemistry laboratories. One intact SS II class was selected from each school through simple random sampling. The two schools were subsequently assigned to the experimental and control groups through simple random sampling. The study focused on quantitative aspects of practical

Chemistry, particularly masses, moles, volumes, concentrations and percentages. These content areas were selected because they constitute essential quantitative skills required for students' understanding and performance in practical Chemistry. The experimental group was taught using the Guided Inquiry-Based Strategy, which involved presenting students with practical problems, guiding them to formulate questions and predictions, plan and conduct experiments, observe and record results, analyse findings and draw conclusions based on experimental evidence. The teacher facilitated the learning process through appropriate questions, hints and guidance without directly providing solutions to the practical tasks. The control group was taught the same content using the conventional lecture method, which involved teacher-directed explanations, demonstrations, questioning and clarification, while students listened, took notes and responded to questions.

The instrument used for data collection was the Quantitative Performance Test (QPT), an essay-type test designed to assess students' performance in quantitative aspects of practical Chemistry, particularly in the area of quantitative analysis. The instrument consisted of two sections. Section A elicited students' biodata, including their school and sex, while Section B contained 50 structured practical Chemistry questions covering the selected content areas. The questions assessed students' knowledge, understanding, practical skills and computational abilities in practical Chemistry, particularly in the area of quantitative analysis. The instrument was developed using a Table of Specification to ensure adequate coverage of the content areas and cognitive levels. Relevant WAEC past practical Chemistry questions, Chief Examiners' Reports and marking guides from 2018 to 2025 were consulted during the development of the test items. The instrument was subjected to face and content validation by three experts from the University of Jos, comprising one expert in Chemistry Education, one in Measurement and Evaluation, and one in Educational Psychology. Their comments and suggestions were used to improve the clarity, relevance, comprehensiveness and appropriateness of the test items. Kendall's coefficient of concordance was also used to determine the degree of agreement among the experts. The reliability of the instrument was established through a pilot study conducted in two public senior secondary schools that were not part of the main study. The split-half reliability method was used to determine the internal consistency of the instrument, while a reliability coefficient of 0.70 and above was considered acceptable. Before the commencement of the treatment, the Quantitative Performance Test (QPT) was administered as a pre-test to both the experimental and control groups to determine their initial performance in practical Chemistry, particularly in the area of quantitative analysis. The test lasted for two hours and thirty minutes and was supervised by the researcher and trained research assistants. The instructional treatment lasted for seven weeks, with one contact period per week, and each lesson lasted for 80 minutes. During the treatment, the experimental group was taught using the Guided Inquiry-Based Strategy, while the control group received instruction through the conventional lecture method. The researcher monitored the instructional sessions to ensure adherence to the prepared lesson plans and consistency in the implementation of the respective instructional approaches. At the end of the seven weeks, the QPT was administered again as a post-test to both groups to determine the effect of the instructional strategies on students' performance in practical Chemistry, particularly in the area of quantitative analysis. The test lasted for two hours and thirty minutes, and the answer scripts were collected and scored using a prepared marking scheme. The QPT consisted of 50 questions, with each correct response attracting two marks and an incorrect response attracting zero marks, giving a maximum obtainable score of 100 and a minimum score of zero. The data collected were analysed using mean and standard deviation to

answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at a 0.05 level of significance. ANCOVA was considered appropriate because it adjusted for initial differences in students' performance using their pre-test scores as a covariate, thereby providing a more accurate assessment of the effect of the Guided Inquiry-Based Strategy on students' performance in practical Chemistry, particularly in the area of quantitative analysis. All statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS), version 26.0.

Results

Research question One

What difference exists in the pre-test and post-test performance mean score of senior secondary two students in practical Chemistry in the experimental and control group?

Table 1: Result of the Analysis on the Pre-test and Post-tests Performance Mean Score of chemistry students in the Experimental and Control Groups

Group	Pre-test		Post-test			Mean gain	Mean difference
	N	$\bar{x}$	SD	$\bar{x}$	Sd		
Experimental	31	46.42	10.91	62.90	11.28	16.48	
Control	30	45.57	12.31	53.60	8.76	8.03	9.30

The results of the analysis from Table 1 reveal that the experimental group had a pre-test mean score of 46.42, SD = 10.19 and a post-test and standard deviation of 42.90, SD = 11.28 with mean gain of 16.48 in favour of the post-test while the control group had a pre-test mean and standard deviation of 45.57, SD = 12.31 and a post-test of 53.60, SD 8.03 with mean gain 9.30 in favour of the post-test. The results indicate that the performance mean of the two groups increased after treatment but that of the experimental group of 62.90 is higher than that of the control group of 53.60 with mean difference of 9.30 this implies that Guided Inquiry-Based Strategy improved senior secondary two student performance in practical Chemistry more than conventional method.

Hypothesis One

There is no significant difference in the pre-test and post-test practical Chemistry performance mean scores of senior secondary two students between the experimental and control groups.

Table 2: ANCOVA Result on the Pre-test and Post-test Practical Chemistry Performance Mean Scores of Students in the Experimental and Control Group

Source	Type III sum of square	Df	Mean Square	F	Sig	Partial Eta squared
Corrected model	3057.562a	2	1528.781	20.573	< 001	.415
Intercept	4379.231	1	4379.231	58.933	< 001	.504
Pregender motivation	1738.029	1	1738.029	23.389	<001	.287
Group	1203.965	1	1203.965	16.202	<001	.218
Error	4309.881	58	34.67274.74.308			
Total	24898.000	61				
Corrected total	7367.443	60				

a R squared = 415 (Adjusted R Squared = 395)

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ANCOVA was conducted to determine if a significant difference exists in the pre-test and post-test performance mean scores of students exposed to Guided Inquiry-Based Strategy and those exposed to conventional method Table 4 shows that F (1,58) = 16.202 P < 0.05 partial n =.218. Since the p- value of 0.0001 is less than the significant level of 0.05, with an effect sizes of 21.8% the null hypothesis was rejected. Therefore, there is a significant difference in the pre-test and post-test performance mean scores of senior secondary two students offering practical Chemistry between the experimental and control group. The results further reveal an adjusted R squared value .395 which implies that 39.50 of the variation in the dependent variable which is performance in practical Chemistry is explained by the variation in the treatment which is Guided Inquiry-Based Strategy while the remaining 60.50 percent is due to other factors not included in this study. This implies that Guided Inquiry-Based Strategy helps to improve SSII students performance in practical Chemistry more than conventional method of teaching practical Chemistry.

Research question Two

What difference exists in the pre-test and post-test performance mean score of senior secondary two students in practical Chemistry in the experimental group based on gender?

Table 3: Results of the Pretest and Posttest Performance Mean Scores of Male and Female Students in the Experimental Group

Group	Pre-test			Post-test		Mean gain	Mean difference
	N	$\bar{x}$	SD	$\bar{x}$	Sd		
Male	18	45.33	10.47	60.66	12.04	15.33	
Female	13	47.92	9.98	66.00	9.76	18.08	5.34

The results of the analysis from Table 3 show that male had a pre-test and post-test practical Chemistry performance mean score and standard deviation of 45.33, SD = 10.47 and 60.66, SD = 12.04 respectively with mean gain of 15.33 in favour of the post-test while female had a pre-test mean score of 47.92, SD = 9.98 and a post-test mean and standard deviation of 66.00, SD = 9.76 with mean gain of 18.08 in favour of the post-test. The results indicate that the mean of the two groups increased, but that of female of 66.00 is higher than that of male of 60.66 with mean different of 5.34. This implies that Guided Inquiry-Based Strategy helps to improve female students' performance in practical Chemistry more than male.

Hypothesis Two

There is no significant difference in the pre-test and post-test performance mean score of SSII students in the experimental group based on gender.

Table 4: Summary of ANCOVA Analysis on the Pre-test and Post-test Performance Mean Scores of Students in Practical Chemistry Based on Gender

Source	Type III Sum of Square	Df	Mean Squared	F	Sig.	Partial Eta Square
Corrected Model	2447.371[a]	2	1223.685	16.974	.001	.515
Intercept	2014.886	1	2014.886	27.949	<.001	.466
Pre-gender Motivation	1402.644	1	1402.644	19.457	.001	.378
Gender	667.701	1	667.701	9.262	.005	.224
Error	2306.915	28	72.091			
Total	113955.000	31				
Corrected Total	4754.386	30				

a R Squared = 515 (Adjusted R squared = .484

ANCOVA was conducted to determine if a significant difference exist in the post-test achievement mean scores of SS II students between male and female students. Table 4 shows that (1,32) = 9.262 p > 0.05 partial = .224. Since the p-value of .005 is less than the significant level of 0.05, with an effect size of .224, we reject the null hypothesis and conclude that there is a significant difference in the performance mean scores of SS II students toward practical Chemistry between the experimental and control group. The results further reveal an adjusted R-squared value of .484 which means that 48.4 % of the variation in the dependent variable which is performance is explained by the variation in the treatment which is guided inquiry strategy while the remaining 51.6 is due to other factors not included in this study. This implies that students' gender significantly affects students' performance in practical Chemistry.

Discussion

The findings of the study revealed that students taught practical Chemistry using Guided Inquiry-Based Strategy (GIBS) obtained higher post-test performance mean scores than those taught using the conventional lecture method. Specifically, the experimental group recorded a pre-test mean score of 46.42 and a post-test mean score of 62.90, representing a mean gain of 16.48. In comparison, the control group recorded a pre-test mean score of 45.57 and a post-test mean score of 53.60, representing a mean gain of 8.03. The difference in the mean gains was 8.45 in favour of the experimental group. Furthermore, the ANCOVA result revealed a statistically significant difference in the adjusted post-test performance scores of students in the experimental and control groups, $F(1, 58) = 16.202$, $p < .001$, partial $\eta^2 = .218$. This finding indicates that students exposed to Guided Inquiry-Based Strategy performed significantly better than those taught using the conventional lecture method. The finding agrees with Akindola et al. (2023), who reported improved Chemistry achievement among students taught using guided inquiry. It also supports the findings of Akinbobola and Afolabi (2020), who reported that guided inquiry enhanced students' achievement in Chemistry compared with conventional instructional approaches. Similarly, Abbey-Kalio (2019) found that students taught practical Chemistry through guided inquiry achieved significantly higher scores than those taught using the conventional demonstration method, particularly in acid-base titration and volumetric analysis. Uzezi and Zainab (2017) also reported that guided-inquiry laboratory experiments improved students' achievement in volumetric analysis compared with traditional teaching approaches. The finding further supports the constructivist perspective of learning, which emphasises students' active involvement in constructing knowledge through meaningful learning experiences. Pedaste et al. (2015) explained that inquiry-based learning involves interconnected phases of orientation, conceptualisation, investigation, conclusion and discussion. These phases provide opportunities for students to explore problems, examine evidence, interpret experimental results and develop scientific explanations. The higher performance recorded by the experimental group may therefore be attributed to the opportunities provided by Guided Inquiry-Based Strategy for students to participate actively in practical investigations, perform calculations, analyse results and construct understanding through guided experimentation. This suggests that guided inquiry can provide a more engaging learning environment for developing students' understanding and application of quantitative Chemistry concepts than the conventional lecture method.

The findings also revealed a difference between the performance of male and female students taught practical Chemistry using Guided Inquiry-Based Strategy. Specifically, male students recorded a pre-test mean score of 45.33 and a post-test mean score of 60.66, representing a mean gain of 15.33. Female students recorded a pre-test mean score of 47.92 and a post-test mean score of 66.00, representing a mean gain of 18.08. The difference in the post-

test mean scores was 5.34 in favour of female students, while the difference in their mean gains was 2.75. Furthermore, the ANCOVA result indicated that the difference in the adjusted post-test performance scores of male and female students was statistically significant, $F(1, 28) = 9.262$, $p = .005$, partial $\eta^2 = .224$. Consequently, the second null hypothesis was rejected. This finding suggests that gender was associated with a statistically significant difference in students' performance within the experimental group, with female students recording the higher unadjusted post-test mean. The finding is consistent with Amadi and Okeke (2019), who reported a significant difference in Chemistry achievement in favour of female students following the use of the Guided Inquiry Teaching Method. However, it differs from Ogunyemi and Bamidele (2019), who reported no significant gender difference when effective instructional strategies were used. Similarly, Jack and Suleiman (2019) found no significant difference between male and female students' Chemistry achievement under Guided-Inquiry and Concept Mapping instructional strategies. Jack and Suleiman (2017) also reported no significant gender effect among students who participated in guided-inquiry laboratory experiments in volumetric analysis. Umanah and Babayemi (2024) equally found no significant difference between male and female students' performance when guided inquiry approaches were used in teaching stoichiometry. The finding also differs from Okpala et al. (2025), who reported no significant interaction between teaching method and gender among SSII Chemistry students exposed to guided inquiry-based learning. These differences may be associated with variations in students' previous learning experiences, classroom participation, school environments, sample characteristics and the implementation of instructional strategies. The higher performance recorded by female students in the present study may suggest that the structured and collaborative nature of guided inquiry provided learning opportunities that supported their engagement with quantitative Chemistry activities. However, this finding should not be interpreted as evidence that female students generally perform better than male students in Chemistry. Rather, it indicates that, within the conditions of this study, female students recorded higher performance scores than their male counterparts following exposure to Guided Inquiry-Based Strategy.

Conclusion

Based on the findings of the study, it was concluded that students taught practical Chemistry using Guided Inquiry-Based Strategy (GIBS) recorded higher post-test performance scores than those taught using the conventional lecture method. This suggests that GIBS can enhance students' understanding and application of quantitative Chemistry concepts by providing opportunities for active participation in practical investigations, experimentation, observation, measurement and analysis. The study also revealed a statistically significant difference in the performance of male and female students taught using GIBS, with female students recording higher post-test mean scores than their male counterparts. This indicates that, within the context of the study, female students performed better than male students following exposure to the strategy. Therefore, Guided Inquiry-Based Strategy is a potentially useful instructional approach for improving students' performance in quantitative aspects of practical Chemistry.

Recommendations

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

1. Chemistry teachers should adopt Guided Inquiry-Based Strategy when teaching quantitative analysis and other practical Chemistry topics. The strategy should be implemented through structured practical activities that encourage students to investigate problems, conduct experiments, record observations, analyse results and draw conclusions.

2. The Ministry of Education, Science Teachers Association of Nigeria (STAN) and relevant Area Education Offices should organise regular professional development programmes for Chemistry teachers. These programmes should focus on guided inquiry lesson planning, effective questioning, instructional scaffolding, laboratory management and the implementation of practical activities. Government and relevant educational authorities should also provide functional laboratories, adequate equipment, chemicals and other instructional resources.
3. Chemistry teachers should ensure equitable participation of male and female students during guided inquiry-based practical activities. Both groups should be given meaningful opportunities to handle laboratory equipment, conduct experiments, make observations, perform calculations, interpret results and participate in group discussions. Teachers should also monitor students' individual progress and provide additional support where necessary.
4. Further studies should be conducted in other local government areas and states to examine the effectiveness of Guided Inquiry-Based Strategy in teaching different Chemistry topics. Future researchers should consider involving more schools, using a larger and more representative sample, and controlling for school- and teacher-related differences to strengthen the validity and generalisability of the findings.

References

Abbey-Kalio, I. (2019). The effect of guided-inquiry approach on senior secondary school students' academic achievement in practical chemistry in Okrika Local Government Area, Rivers State, Nigeria. *Direct Research Journal of Social Science and Educational Studies, 6*(9), 138–142. https://doi.org/10.26765/DRJSSES2648391709

Abrahams, I., & Reiss, M. J. (2017). The role of practical work in science education. *School Science Review, 98*(365), 101–107. https://doi.org/10.1080/09500693.2017.1281026

Adewumi, G. S., & Adejoke, A. A. (2023). Effect of two instructional strategies on students' science process skills in selected abstract concepts in biology in Kwara State, Nigeria. *Journal of Science, Technology and Mathematics Pedagogy, 1*(1), 242–258. https://jostmp-ksu.com.ng/index.php/jostmp/citationstylelanguage/get/acs-nano?publicationId=30&submissionId=30

Adeyemi, B. A., & Ajiboye, T. O. (2022). Effects of guided inquiry strategy on students' academic performance in science. *International Journal of Educational Research, 11*(3), 112–120. https://jeteraps.scholarlinkresearch.org

Adoga, A. (2023). The influence of socio-cultural factors on gender participation in science education in Nigeria. *International Journal of STEM Education, 10*(1), 1–12. https://www.academia.edu

Akindola, O. S., Ibiye, O. A., & Gana, E. S. (2023). Effect of guided inquiry strategy on students' achievement in chemistry. *Journal of Educational Studies, 18*(1), 67–79. https://nampjournals.org.ng

Akinbobola, A. O., & Afolabi, F. (2020). Effects of guided inquiry and demonstration methods on students' achievement and retention in chemistry in Ondo State, Nigeria. *Journal of Science Education, 12*(2), 45–59. https://ir.unilag.edu.ng

Ajayi, O. V., & Ogbeba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Research, 5*(8), 839–842. https://doi.org/10.12691/education-5-8-1

Ajayi, O. V., & Olatunbosun, S. M. (2021). Effects of guided inquiry instructional strategy on students' achievement and retention in senior secondary school chemistry in Oyo State, Nigeria. *Journal of Educational Research and Practice, 11*(1), 88–102. https://scholar.google.com

Alune, A., & Emmanuel, G. (2022). The effect of chemistry practicals on students' academic performance in Tanzania. *Journal of Mathematics and Science Teacher, 2*(2), 1–8. https://www.researchgate.net

Amadi, V. E., & Okeke, S. O. C. (2019). Effect of guided inquiry teaching method on secondary school students' academic achievement in chemistry in Awka Education Zone. *UNIZIK Journal of STM Education, 3*(1), 166–178. https://journals.unizik.edu.ng/jstme/issue/view/48

Apeadido, G., Opoku-Mensah, K., & Mensah, J. (2024). Practical inquiry-based science instruction and student achievement. *African Journal of Science Education, 9*(1), 21–35. https://www.mendeley.com

Audu, H. S., Jaji, N., Hameed Mohammed, A., & Mohammed Sambo, S. (2023). The role of chemistry education in combating insecurity and economic challenges in Nigeria. *Azare Journal of Education, 10*(2), 25–32.

Domenici, V. (2022). Inquiry-based laboratory activities in chemistry education: A review of benefits and challenges. *Journal of Chemical Education, 99*(5), 1234–1245. https://pubs.acs.org

Dushimimana, F., & Mugabo, L. (2022). Effects of inquiry-based teaching method on students' academic performance and attitudes towards chemistry in two selected secondary schools of Bugesera District, Rwanda. *Journal of Research Innovation and Implications in Education, 6*(2), 44–56. https://jriiejournal.com/wp-content/uploads/2022/04/JRIIE-6-2-006.pdf

Elvira, M., Rohaeti, E., Retnawati, H., & Sainuddin, S. (2023). Measurement of students' chemistry practicum skills using the many-facets Rasch model. *European Journal of Educational Research, 12*(1), 89–103. https://doi.org/10.12973/eu-jer.12.1.89

Fatma, A. (2021). Problem solving in chemistry: Example of neutralization titration. *Journal of Education Studies Trends and Practices, 11*(2), 306–328. https://scholar.google.com

Federal Ministry of Education. (2021). *Number of students enrolled in junior secondary schools in Nigeria (2018/2019).* Statista. https://www.statista.com

Hofstein, A., & Kind, P. (2018). Learning in and from science laboratories. *Studies in Science Education, 54*(2), 151–192. https://www.tandfonline.com

Igboanugo, B. I. (2023). Interactive effects of guided inquiry and teachers' experience on chemistry students' interest. *Journal of Chemistry, 2023*, Article 9970946. https://doi.org/10.1155/2023/9970946

Jack, G. U., & Gisum, J. B. (2024). Gender differences in students' self-efficacy, academic performance, and retention in mole concept using Krall's five-step problem-based learning model. *Trends in Educational Studies Journal, 16*(2), 107–119. https://tresjournal.com.ng

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

Nasarawa Eggon and Mada Station Area Education Offices, Nasarawa Eggon Local Government Area, Nasarawa State. (2025). *Students' performance in Chemistry in WAEC, NECO and NABTEB examinations, 2016–2025* [Unpublished internal report].

Ojelade, I. A., Ubom, A. E. B., & Suleiman, R. O. (2026). Effects of guided inquiry-based instruction on achievement and retention in secondary school chemistry: A quasi-experimental study. *International Journal of Innovative Social & Science Education Research, 14*(1), 101–110. https://doi.org/10.5281/zenodo.18331283

Ogunleye, A., Olatunji, S., & Adeyemi, S. (2022). Effectiveness of formative assessment on students' practical skills in secondary schools in Nigeria. *International Journal of Educational Research, 1*(3), 3–12. https://www.academia.edu

Ogunyemi, T. C., & Bamidele, E. O. (2019). Gender influence on students' perception in learning chemistry using multiple representations in Nigerian secondary schools. *Asian Journal of Education and Social Studies, 5*(1), 1–7. https://doi.org/10.9734/AJESS/2019/v5i130135

Ojo, O. T., & Tijani, B. E. (2025). Influence of gender on chemistry students' acquisition of science process skills using open inquiry strategy. *African Multidisciplinary Journal of Development, 13*(2), 133–143. https://www.academia.edu

Okpala, N. M., Onyia, C. N., & Udu, D. A. (2025). Guided inquiry in chemistry classrooms: Investigating its effects on student interest and achievement in secondary schools in Enugu State, Nigeria. *Greener Journal of Educational Research, 15*(1), 224–232. https://doi.org/10.15580/GJER.2025.1.092325142

Olubunmi, O. A., & Aarinola, A. M. (2022). Implementation of chemistry curriculum in Nigeria: Challenges for the 21st century. *World Journal of Educational Research, 9*(2). https://www.scholink.org/ojs/index.php/wjer/article/view/4553

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review, 14*, 47–61. https://doi.org/10.1016/j.edurev.2015.02.003

Sadeh, I., & Zion, M. (2019). Scientific reasoning development through inquiry-based learning. *International Journal of Science Education, 41*(12), 1584–1605. https://doi.org/10.1080/09500693.2019.1612128

Seery, M. K., Agustian, H. Y., Christiansen, F. V., Gammelgaard, B., & Malm, R. H. (2024). 10 guiding principles for learning in the laboratory. *Chemistry Education Research and Practice, 25*, 383–402. https://doi.org/10.1039/D3RP00245D

Shawai, S. A. A., Muhammad, I. I., Muzammil, M., & Gwarzo, F. S. (2022). Comparative analysis of gender performances in practical activities among senior secondary school science students in Kano Municipal Local Government Area, Kano State. *International Journal of Scientific Research in Chemical Sciences, 9*(5), 20–26. https://www.isroset.org/journal/IJSRMS/full_paper_view.php?paper_id=2980

Umahaba, R. E., Gambari, A. I., Thomas, G., & Asaph, R. R. (2026). Effect of process-oriented guided inquiry learning strategy on students' academic performance in organic chemistry in Kwami Local Government Area of Gombe State, Nigeria. *Discover Education*. https://doi.org/10.1007/s44217-026-01411-2

Umanah, F. I., & Babayemi, J. O. (2024). Peer-led and teacher-led guided inquiry teaching approaches on students' academic performance in chemistry. *UNIZIK Journal of STM Education, 7*(1), 151–162. https://journals.unizik.edu.ng/jstme/article/view/4256

UNICEF. (2020). *Gender-responsive pedagogy: A toolkit for teachers and schools.* https://www.unicef.org

Uzezi, J. G., & Zainab, S. (2017). Effectiveness of guided-inquiry laboratory experiments on senior secondary school students' academic achievement in volumetric analysis. *American Journal of Educational Research, 5*(7), 717–724. https://doi.org/10.12691/education-5-7-4

West African Examinations Council. (2023). *Chemistry paper 3, May–June 2023 past questions from 2015 to 2024.* https://registration.waecdirect.org