Enhancing Students' Academic Achievement and Bridging Ability and Gender Groupings in Quantitative Analysis Through Laboratory Method in Secondary School Chemistry

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ABSTRACT

The study was marked at examining and comparing the effect of laboratory method with lecture methods in teaching quantitative analysis on students' achievements, ability and gender in Secondary School Chemistry Practical. The design of the study was a non-randomised pre-test, post-test control group quasi-experimental design. One hundred and ninety-eight (198) students in six (6) intact classes from different local Government Areas in Delta Central Senatorial District made up the sample for the study. The instruments for the study consisted of Chemistry Practical Ability Test (CPAT). The instrument was validated and its reliability determined using Pearson Product Moment Correlation Coefficient. The reliability coefficient was r = 0.707. The instrument was administered to sampled students before and after the treatment to establish cause and effect on the methods. Data were collected and analysed. The findings of the study were: Laboratory method enhanced students' achievement in quantitative analysis significantly [F (2, 172) = 1.637; P (0.000) < 0.05] than the conventional method of teaching using lecture method. In terms of sex, the laboratory method enhanced the female learners significantly [F (2, 172) = 0.23; P (0.000) < 0.05] in achievement than the male learners. However, the mean scores difference between pretest and post-test in achievement bared that the gap between gender grouping is better bridged with the male. For the ability learners, there is significant difference in the mean achievement scores [F (2, 172) = 0.117; P (0.000) < 0.05] in favour of the high ability leaners but the existing gap between the high and low ability learners were highly reduced. The interaction effect of methods on ability and gender was not significant [F (2, 172) = 3.365; P (0.0680) > 0.05]. Based on the findings, a recommendation was made that laboratory method should be engaged frequently in teaching quantitative analysis as practical aspects of Chemistry beginning from Senior Secondary School I; The conclusion of the study was that laboratory method enhanced students' achievements in quantitative analysis and thus improved the female and high ability level students but more gaps were bridged in the male and low ability level students than female and high ability level students.

Keywords: Quantitative Analysis, Achievement, Lecture Method, Laboratory Method, Ability, Gender.

INTRODUCTION

The teaching of chemistry practical concepts to students in both secondary and higher learning is no doubt a great purpose in the world of science. Chemistry is both theoretical and practical; it is complementary as teaching - learning process goes. The theoretical section of chemistry can be taught by varieties of methods, but its practical content requires the use of experimental approach for adequate transmission of target knowledge. Hence, chemistry practical is known for its skillful scientific process, creativity, technological development and demonstration of positive attitude towards science (Ibrahim, Tairo, Aminu, Isah & Muhammad, 2017; Azeez, Oguhce, Omananyi, Kwasi, Ejeh & Toluhi, 2025). As such, the practical branch of chemistry cannot be avoided, however, owing to students' unscientific attitude to science learning, the level of academic performance, acquisition of skills and problem solving particularly in practical chemistry has been noted to be poor. Consequently, these have resulted to huge deterioration in chemistry practical approach (Asum, Bassey and Essien, 2005; Oloruntegbe & Oduntuji, 2005; WAEC, 2006 Ihuarulam, 2008; Alkan, (2021); Beichumilla, Bahati & Kafanaho, 2022; Efe & Abamba, 2023). Practical chemistry is designed to enhance teacher's subject

knowledge significantly, build confidence, foster better pedagogical techniques, move lessons beyond theoretical lecturing and bridge the gap between abstract concepts and real-world application (Anim-Eduful & Forson, 2025). Also, it is to improve students' engagement, critical thinking skills, learning outcomes and unveiling the abstractions in the target knowledge for better understanding (Walter, 2021). These relevancies are considered a required engagement at the secondary level to familiarize students with such mental processes needed; stimulate students' interest in chemistry; help retain knowledge; induce the scientific attitudes and skills such as curiosity, critical thinking, perseverance, open mindedness, objectivity, honesty and so on.

Practical activities in both internal and external chemistry examinations in secondary schools largely focus on quantitative and qualitative analyses, other areas seldom questioned include preparation and test for gases, heat change, separation techniques and oxidation & reduction processes. All of these require laboratory methods to help students' grasp of basic theoretical concepts. It further exposes students to experimental work and creates room for greater retention of concepts. However, students' performances in certificate examinations like West African Examination Council (WAEC), National Examination Council (NECO) and National Administration Basic Technical Examination Board (NABTEB) have been consistently low over time (Eze & Okorie, 2019; Adu-Gyamfi, Ampiah & Agyei, 2020; Onyi, Njoku & Nwafor, 2022; Odukwe & Nwafor, 2022; Aniodoh & Eze, 2022; Efe & Abamba, 2023).

Efe & Abamba (2023) noted that the WAEC Chief Examiner 's Reports linked the poorest performances in chemistry to a several deficiencies found in both quantitative and qualitative analyses which was traced to students' lack of practical experiences, hence theoretical answers were given to practical questions. Again, the Chief Examiner 's Reports showed that students are inadequately exposed to practical work, as such, they could not record observations and inferences made; lacked accuracy in burette readings and understanding of the demands of questions; could not adhere to rubrics; lacked manipulative skills; and could not draw logical inferences from observations made (Alkan, (2021; WAEC, 2022). In view of these, there is the need to give deliberate attention to practical work in our schools using thorough laboratory methods to enhance students' academic achievement and skills in Chemistry. It is on this note that this study seeks to strengthen the knowledge of quantitative analysis through laboratory methods.

Quantitative analysis is one of the vital practical areas in chemistry used in identifying and measuring the chemical components of samples. This method of analysis involves acquisition and engagement of process skills such as observation, measurement, communication, tabulation, identification, prediction, classification, inference, formulation of hypothesis, controlling, manipulation of apparatus, interpretation of data, experimentation, mathematical computation of results & calculations, raising of questions, and so on (Valentino, 2000; Alkan, (2021); Efe & Abamba, 2023; Chinda & Achigbe, 2024). In schools, colleges and institutions, quantitative analysis has been found to be very useful in various ways; acquisition and exhibition of good science process skills, environmental analysis, forensic science, scientific predictions, material analysis, bioanalysis, development of both financial and material industries, and so on. Therefore, the knowledge of quantitative analysis in Chemistry at secondary school level is an unavoidable one since it is basic for all science students in schools, colleges and institutions.

In addition, Quantitative analysis is relevant across diverse fields of life like business, sciences, technology, medicine and social sciences. This is so because of its systematic numerical approach to understanding, measuring and predicting outcome. Hence, its relevant found in business risk management; space science (Ackerman, 2005); safety and efficiency of drugs; foods and petrol chemical industries; ecological study in determining relationship between brain structure and sensory ecology of aquatic animals; metal application and several other areas of scientific endeavours (Lisney, Bernnett & Collin, 2007; Eyisi, 2016; Zhang 2020; Abuhamda, Ismail & Bsharat, 2021; Pilcher & Cortazzi, 2023).

In view of academic achievement among learners, it is generally a concern to parents, administrators, examining bodies and other stakeholders in education. Academic achievement refers to the accomplishments or successes that a person attains in his or her pursuit of educational work. It is a vital factor in the teaching and learning process of any system. So, it forms the outcome of instruction, mastery of learning content and evaluation (Usang & Josephine, 2021). This includes things like grades, awards, degrees, or other formal recognitions of academic excellence obtained through a test or examination (Abd, Andi, & Muhpammad, 2020; Konyefa & Okigbo, 2021)

It reflects a person's intellectual or academic abilities and how well they perform in a school or university setting. Considering several deficiencies observed as noted earlier in quantitative analysis and the dwindling performance, this study becomes necessary to determine the effect of laboratory method on achievement.

The issue of sex or gender on achievement, attitude, retention, subject interest and so on has remained inconclusive Several researchers have different results either in favour or against any of the sex pair or gender. Gender refers to the roles, behaviour activities and identities that is considered appropriate for men or women. Here it influences how individuals see themselves and how they are perceived in environment socially and psychologically. Issues have been linked with performance of students in academic tasks in several studies but without any definite conclusion. Gender is a personal variable that has been proved to have considerable influences on students' academic self-efficacy and performance (Ushie & Edinyang, 2018). The influence of gender and its interaction with instructional strategies have remained an issue of continual study. Studies had shown that certain instructional strategies favour males more than females and others reported otherwise. Some teaching strategies tend to be gender sensitive (Izuegbunam, 2018) while others are more gender bias or specific (Nwanze, 2016). Effective instructional strategies, however, must have the potency to positively enhance performance irrespective of students' gender. Again, the level of mastery of skills as required in quantitative analysis may differ among male and female students due to strengths and weaknesses often observed resulting to in certain inherent virtues, hence the study.

Another variable considered is the learner's ability level; this refers to the natural or acquired capacity of an individual to perform a task or activity effectively. It is what someone can do, either because of their innate talents or through learning and experience. There are two main types of abilities, namely; innate (natural); abilities one is born with, such as musical talent, physical coordination, or logical thinking. Secondly, acquired abilities being developed skills through education, practice, and experience, such as reading, writing, coding or public speaking. Ability plays a critical role in determining how well a person can perform in any given task. The build of natural abilities in any individual sum up the categorised class of ability. Some are high, others are either moderate (average or middle) or low. For this study, high and low ability was considered. High ability students are those with better performance and more likely to solve complex problems quickly and accurately. This category of abilities helps students grasp concepts more easily and apply them effectively. They are also fast Learners with strong verbal or logical reasoning abilities often learn new material more. The low ability students are contrary; they are slow learners with poor performance. They have much difficulty in solving or resolving problems on their own.

Studies have done investigation on method/sex interaction or method/ability level interaction, rarely all three together on quantitative/qualitative analysis specifically. This suggests a genuine gap the study could fill.

Statement of the Problem

Practical Chemistry in secondary school constitutes paper 1 of the two papers students are examined to get their final score in Chemistry. Practical Chemistry is vital since the questions asked require students to demonstrate Science Process Skills in both quantitative (titration) and qualitative analyses. The failures over time in chemistry partly points to students' inability to carry out practical exercises and the approach employed. It has become imperative to examine if students' achievement, gender and ability groupings are enhanced by laboratory method better than lecture method. Therefore, will the teaching of quantitative analysis using laboratory method enhance student achievement with respect to gender and varying ability of the students in Senior Secondary School Chemistry?

Objective of the Study

The study specifically investigates the following:

- Whether there exists significant difference in students' achievement scores in quantitative analysis between those taught with laboratory method and lecture method.
- Examine the effect of laboratory method and lecture method on students' achievement in quantitative analysis in Senior Secondary School Chemistry.

- The interaction effect of the methods on achievement, ability and gender of students taught quantitative analysis

METHODOLOGY

The study employed a non-randomized pre-test, post-test control group quasi-experimental design with population size of twenty-five thousand, eight hundred and eighty-six (25,886) students at Senior Secondary School Two (SS2) across one hundred and forty-nine (149) public schools spread across the eight (8) local government areas of Delta Central Senatorial District. Six (6) chemistry teachers and one hundred and ninety-eight (198) senior secondary school (SS2) hemistry students from six (6) selected secondary schools having chemistry laboratories in Delta Central Senatorial District were sampled using stratified random sampling to avoid the problem of inadequate Chemistry laboratory facilities. The one hundred and ninety-eight (198) Senior Secondary School Two (SS2) Chemistry students were from intact classes of the sampled schools comprising of both males and females. Three schools were used as experimental group while the other three schools as control group. The Chemistry Practical Ability Test (CPAT) was administered first to the SS2 chemistry students from the sampled schools to get the pretest scores. The trained research assistants were used to both teach experimental group using laboratory method and control group using lecture method. Thereafter, CPAT was administered again to get post-test scores. The responses retrieved were computed as data and then analysed.

Research questions

To what extent does the mean achievement scores of students taught quantitative analysis using laboratory differ lecture methods?

How does the mean achievement scores of high ability students different from those of low ability students when taught quantitative analysis using laboratory and lecture methods?

What is difference between the mean achievement scores of male and female students taught quantitative analysis using laboratory and lecture methods?

What are the interaction effects of the methods on ability and gender of students taught quantitative analysis in the mean achievement scores.

Hypotheses

There is no significant difference between the use of laboratory and lecture methods in the mean achievement scores of students taught quantitative analysis.

There is no significant difference in the mean achievement scores of high and low ability students taught quantitative analysis using laboratory and lecture methods.

There is no significant difference between the use of laboratory and lecture methods in the mean achievement scores of male and female students taught quantitative analysis

There are no significant interaction effects of the methods on ability and gender of students taught quantitative analysis in the mean achievement scores.

Results and discussions

The data obtained were analysed and presented as follows:

Research Question 1

To what extent does the mean achievement scores of students taught quantitative analysis using laboratory differ lecture methods?

To answer this research question, the pre-test and post-test mean achievement scores of students taught quantitative analysis using laboratory and lecture methods of teaching were analysed and compared as shown in table 1.

Table 1: Mean and Standard Deviation on students' achievement scores in quantitative analysis using laboratory and lecture methods.

Method	Pre-test scores			Post-test scores			
	N	*x*	SD	*x*	SD	*x* diff	%diff
Lecture	111	8.3604	5.9019	11.3153	6.3789	2.9549	26.11
Laboratory	87	6.9770	6.5343	19.1264	7.6078	12.1494	63.52

Table 1 revealed a pre-test mean achievement score of 8.3604 with standard deviation of 5.9019 for students taught quantitative analysis using lecture method while the pre-test mean achievement scores for students taught quantitative analysis using laboratory indicated 6.9770 with standard deviation being 6.5343. The post-test means achievement score of 11.3153 with standard deviation of 6.3789 for students taught quantitative analysis using lecture method while the post-test mean achievement scores for students taught quantitative analysis using laboratory indicated 19.1264 with standard deviation being 7.6078. A further examination on the result obtained as indicated in table 1 revealed that the mean difference between the pre-test and post-test scores for students taught quantitative analysis using both methods are 2.9549 and 12.1494 respectively. Consequently, the percentage difference of the mean achievement shows 26.11% for those taught with lecture method and 63.52% for those taught with laboratory method. The mean difference favours laboratory method of teaching, indicating its effectiveness in quantitative analysis.

Hypothesis 1

Ho_1: There is no significant difference between the mean achievement scores of students taught quantitative analysis using laboratory method and those taught with lecture method.

This hypothesis was tested using t-test to compare the post-test mean achievement scores of students taught quantitative analysis using laboratory and lecture methods in table 2.

Table 2: Summary of t-test comparison of post-test mean achievement scores students taught quantitative analysis using laboratory method and conventional method.

Methods	N	*x*	SD	F	Sig	t	dt	P-value	*x* diff
lecture	111	14.9540	6.6489	1.637	.202	3.852	172	.000	-4.1724
Laboratory	87	19.1264	7.6078						

Table 2 showed that the comparison of the post-test mean achievement scores of students taught quantitative analysis using laboratory method affirms a difference that is statistically significant. $F(2, 172) = 1.637$; $P(0.000) < 0.05$. Therefore, the null hypothesis is not accepted since the mean achievement scores of students taught quantitative analysis using laboratory method are significantly different as reflected in table 2.

Research Question 2

How does the mean achievement scores of high ability students different from those of low ability students when taught quantitative analysis using laboratory and lecture methods?

To answer this research question, the pre-test and post-test mean achievement scores of high and low ability level students taught quantitative analysis using laboratory method were analysed and compared as shown in table 3.

Table 3: Mean and Standard Deviation on students' achievement scores of high and low ability students in quantitative analysis using laboratory method.

Ability level		N	*x*	SD	*x* diff	%diff
High	Pre-test	64	8.0469	7.0743	15.3006	65.67
	Post-test		23.4375	5.4127		
Low	Pre-test	110	1.9455	2.3882	11.3727	85.39
	Post-test		13.3182	5.7052		

Table 3 revealed a post-test mean achievement score of 23.4375 with standard deviation of 5.4127 for high ability level students taught quantitative analysis using laboratory method while the mean achievement score for low ability level students indicated 13.3182 with standard deviation being 5.7052. A further examination on the result obtained as indicated in table 3 revealed that the mean difference and percentage difference between the pre-test and post-test scores for high ability level students are 15.3006 and 65.67% respectively while those of low-level ability students reveal 11.3727 and 85.39% respectively. Though, the initial existing gap between the high and low ability level students before treatment showed a better performance in favour of high ability students but with the treatment, the mean difference favours the low ability level students with percentage difference of 19.72. However, the effect of laboratory method improved the low ability level students by bridging the existing gap.

Hypothesis 2

Ho_2: There is no significant difference between the mean achievement scores of high and low ability students taught quantitative analysis using laboratory method.

This hypothesis was tested using t-test to compare posttest mean achievement scores of high and low ability level students taught quantitative analyses using laboratory method as shown in table 4.

Table 4: Summary of t-test comparison of post-test mean achievement scores of high and low ability students taught quantitative analyses using laboratory method.

Ability	N	*x*	SD	F	Sig.	t	dt	P-value	*x* diff
High	64	23.4375	5.4127	.117	.733	11.494	172	.000	10.1193
Low	110	13.3182	5.7052						

Table 4 showed the comparison of the post-test mean achievement scores of high and low ability students taught qualitative and quantitative analyses using laboratory method. It affirms a difference that is statistically significant. F (2, 172) = 0.117; P (0.000) < 0.05. Therefore, the null hypothesis is not accepted since the mean achievement scores of high and low ability students taught quantitative analysis using laboratory method are enhanced by a significant difference as represented in table 4.

Research Question 3

What is difference between mean achievements scores of male and female students taught quantitative analysis using laboratory method?

To answer this research question, the pre-test and post-test mean achievements scores of male and female students taught quantitative analysis using laboratory method were analysed and compared as shown in table 5.

Table 5: Mean and Standard Deviation on students' achievement scores of male and female students in quantitative analysis using laboratory method.

Gender		N	*x*	SD	*x* diff	%diff
Male	Pre-test	86	3.2326	5.0937	11.6162	78.23
	Post-test		14.8488	7.0536		

Female	Pre-test	88	5.1250	5.7930	14.0568	73.28
	Post-test		19.1818	7.1848		

Table 5 revealed a post-test mean achievement score of 14.8488 with standard deviation of 7.0536 for male students taught quantitative analysis using laboratory method while the mean achievement score for female students indicated 19.1818 with standard deviation being 7.1848. A further consideration on the result obtained as indicated in table 5 revealed that the mean difference between the pre-test and post-test scores for male and female students are 11.6162 and 14.0568 respectively in favour of the female students. However, there is a considerable improvement on the part of the male with the use of the laboratory method hence a higher percentage of 78.23% compared to 73.28% of the females as indicated in table 5,

Hypothesis 3

H_{O3}: There is no significant difference between the mean achievement scores of male and female students taught quantitative analysis using laboratory method.

This hypothesis was tested using t-test to compare the posttest mean achievement scores of male and female students taught quantitative analysis using laboratory method in table 6.

Table 6: Summary of t-test comparison of posttest mean achievement scores male and female students taught quantitative analysis using laboratory method.

Gender	N	*x*	SD	F	Sig.	t	dt	P-value	*x* diff
Male	86	14.8488	7.0536	.023	.880	-4.013	172	.000	-4.33298
Female	88	19.1818	7.1848						

Table 6 revealed the comparison of the post-test mean achievement scores of male and female students taught quantitative analysis using laboratory method. It affirms a mean difference that is statistically significant. $F(2, 172) = 0.23$; $P(0.000) < 0.05$. In addition, the negative t-value (-4.013) shows that the use of laboratory method was considerably effective. Therefore, the null hypothesis is not accepted since the mean achievement scores between male and female students taught qualitative and quantitative analyses using laboratory method are enhanced by a significant difference as represented in table 6.

Research Question 4

What are the interaction effects of the methods on ability and gender of students taught quantitative analysis in the mean achievement scores.

To answer this research question, the post-test means achievement scores of both ability and sex as it relates to the methods in quantitative analysis were analysed and compared as shown in table 7.

Table 7: Posttest Mean and Standard Deviation of interaction effect of methods on students' achievement scores, ability and gender in quantitative analysis.

Teaching Methods	Students' Ability	Gender	N	Mean	Std. Deviation	Gender Mean difference	Ability mean difference
Lecture Method	High Ability	Male	26	24.8462	5.59065	- 4.2591 (15.99%)	16.4044 (61.57%)
		Female	19	29.1053	7.71647		
		Total	45	26.6444	6.82960		
	Low Ability	Male	41	11.2683	4.15947	1.0283 (9.45%)	
		Female	25	10.2400	4.83287		
		Total	66	10.8788	4.41855		
	Total	Male	67	16.5373	8.17114	- 1.8491 (10.71%)	
		Female	44	18.3864	11.28328		
		Total	111	17.2703	9.52122		

Laboratory Method	High Ability	Male	10	45.7000	5.75519	- 1.7091 (3.65%)	20.2386 (59.39%)
		Female	22	47.4091	6.71643		
		Total	32	46.8750	6.38926		
	Low Ability	Male	33	24.8485	9.34452	- 4.4697 (16.78%)	
		Female	22	29.3182	11.04703		
		Total	55	26.6364	10.20233		
	Total	Male	43	29.6977	12.37227		
		Female	44	38.3636	12.85897		
		Total	87	34.0805	13.28246		

Table 7 revealed a post-test mean achievement score of high ability male (24.8462) and female (29.1053) students taught with lecture and those of low ability levels being 11.2683 for male and 10.2400 for female. Similarly, post-test mean achievement score for those taught with laboratory showed 45.7000 and 47.4091 for male and female high ability students respectively while 24.8485 and 29.3182 male and female respectively for low ability level students. The gender mean difference for those taught lecture method showed 4.2591 (15.99%) in favour of the females for high ability student and 1.0283 (9.45%) in favour of the male. Considering those taught with laboratory method, the gender mean difference showed 1.7091 (3.65%) for high ability students and 4.4697 (16.78%) for low ability students both in favour of the females. The comparison of the high and low ability level students in respect of ability mean difference for lecture method showed 16.4044 (61.57%) while for laboratory method showed 20.2386 (59.39%) all in favour of high ability level students.

Hypothesis 4

Ho_4: There are no significant interaction effects of the methods on ability and gender of students taught quantitative analysis in the mean achievement scores.

This hypothesis was tested using analysis of variance to compare the achievement scores of the gender and ability groupings with methods as shown in table 8.

Table 8: Summary of t-test comparison of interaction effect of methods on ability and gender of students taught quantitative analysis in achievement scores.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	29218.430[a]	7	4174.061	81.691	.000
Intercept	131700.779	1	131700.779	2577.523	.000
Methods	13691.549	1	13691.549	267.958	.000
Ability	13527.894	1	13527.894	264.755	.000
Gender	235.046	1	235.046	4.600	.033
Methods * Ability	112.135	1	112.135	2.195	.140
Methods * Gender	23.070	1	23.070	.452	.502
Gender * Ability	16.949	1	16.949	.332	.565
Methods * Ability * Gender	171.944	1	171.944	3.365	.068
Error	9708.216	190	51.096		
Total	159300.000	198			
Corrected Total	38926.646	197			
a. R Squared = .751 (Adjusted R Squared = .741)					

Table 8 revealed the interaction effect of the methods on ability and gender of students taught quantitative analyses in the mean achievement scores. It affirms that the interaction effect is not statistically significant, F (2, 172) = 3.365; P (0.068) > 0.05. Therefore, the null hypothesis is accepted since the interaction effect of method on ability and gender is not significant. However, there are significant effects for methods (P (0.000) < 0.05), students' ability (P (0.000) < 0.05) and sex (P (0.033) < 0.05). The interaction effects of methods on students' ability (P (0.140) > 0.05); methods on gender (P (0.502) > 0.05) and gender on students' ability are not significant.

DISCUSSION OF RESULTS

The study determined the effects of laboratory and lecture method on students' achievement, ability and gender in quantitative analysis in Senior Secondary Schools in Delta, Nigeria. The results showed that both groups taught quantitative analysis improved in academic achievement. It further revealed that the mean difference between the pre-test and post-test scores for students taught quantitative analysis using lecture (2.9549) and laboratory (12.1494) methods are quite wide. So, the percentage difference of 26.11% for those taught with lecture method and 63.52% for those taught with laboratory method affirmed that laboratory method of teaching has effectively enhanced the performances of students in quantitative analysis. Again, the comparison of the post-test mean achievement scores of students taught quantitative analysis using both methods affirmed a difference that is statistically significant, P (0.000) < 0.05. So, the mean achievement scores of students taught quantitative analysis using laboratory method are better than those with the lecture method of teaching. This result is in consonance with the view of Shana & Abulibdeh (2020); Afyusisye & Gakuba, (2022); Efe, & Abamba, (2023); Ekpo & Mfam. (2025); stating that laboratory activity method proved more effective than conventional methods of teaching.

Also, the result on ability levels of students revealed that the mean difference and percentage difference between the pre-test and post-test scores for high ability level students are 15.3006 and 65.67% respectively while those of low-level ability students revealed 11.3727 and 85.39% respectively. Both levels of abilities improved in their performances with the use of laboratory method. The initial state of the high ability level students' prior treatment showed a better performance when compared with the low ability level students. After treatment, the result showed that high ability level students did better with a post mean score of 23.4375 than those of low ability students which had 13.3182. Nevertheless, the effect of laboratory method on the low ability level students improved with a percentage difference of 19.72 higher than their counter parts. This result is supported by Ogunmade, Olajide and Ogunmade, (2024). As such, the use of laboratory method bridged the existing gap between high and low ability level students. This difference is further affirmed by the comparison of the post-test mean achievement scores of high and low ability students taught quantitative analysis using laboratory method stating that, it is statistically significant; P (0.000) < 0.05. Therefore, the null hypothesis is not accepted since the mean achievement scores of high and low ability students taught quantitative analysis using laboratory method are enhanced by significant differences.

The result from table 5 displayed that the mean difference between the pre-test and post-test scores for male and female students are 11.6162 and 14.0568 respectively. It infers that the female students are well enhanced in the performance than their male counter parts using laboratory method of teaching. However, a considerable improvement is observed on the part of the male hence a higher percentage mean difference of 78.23% compared to 73.28% of the females as indicated in table 5. Again, table 6 revealed the comparison of the post-test mean achievement scores of male and female students taught quantitative analysis using laboratory method affirmed a mean difference that is statistically significant; P (0.000) < 0.05 which does not support the view of Tsobaza, and Njoku, (2021); Chikendu and Okoli (2025); Tajuddeen and Ibrahim (2026) but agrees with the work of Okeke, (2018) and Abuh, (2021) using innovative strategies.

The interaction effects of the methods on ability and gender of students taught quantitative analysis in mean achievement scores bared that the females in high and low ability level students performed better with laboratory method than the male counter parts in both levels. With the conventional method, female performed better for high ability and male for low ability. Therefore, the interaction effects of the methods on ability and gender favours female students of low ability. It simply infers that the gap between the gender and ability groupings is bridged with the use of both methods but better bridged with laboratory method than the lecture method of teaching. Again, the interaction effect of the methods on ability and gender in mean achievement scores for students taught quantitative analyses revealed that methods on ability and gender of students taught quantitative analysis are not statistically significant, P (0.068) > 0.05. Therefore, the null hypothesis is accepted. This is supported by the work of Atomatofa, R. O. (2014); Tsobaza, & Njoku, (2021); Chikendu & Okoli (2025); Zudonu, O. C. (2025), stating that the interaction effect of teaching methods on gender, ability, interest and so on were not significantly different in their mean achievement scores but differ from the work of Okeke, (2018) and Abuh, (2021). This suggests that the students' achievement scores relative to the student's ability and gender

groupings are not influenced by the teaching methods. So, the effect of the teaching methods does not alter the students' gender and their inherent ability.

CONCLUSION

Based on the result of the study, the following conclusion was reached:

1. Laboratory method of instruction is effective in enhancing performance of learners in quantitative analysis in Senior Secondary School chemistry. The performance improvement was more in females and low-level ability students than the males and high-level ability students. This may be because of the challenges prompted in course of interactions and over confidence on the part of the high ability students.
2. Again, the use of laboratory method enhanced the female learners and the low ability learners more in achievement than the male and high ability learners. This may be associated with careful attention given by female learners in appropriating the science process skills contrary to the hasty displayed by the male counterpart.
3. In considering the gap noted from the pre-test mean achievement scores between the male & female and high & low ability level students, contrary to the conclusion in 2, the gap was greatly bridged indicating that the female and low ability level students improved better with laboratory method.

RECOMMENDATION

That laboratory method should be engaged in teaching quantitative analysis as practical aspects of Chemistry beginning from Senior Secondary School I while adequate time should be given to practical to ensure full grasp of required skills.

REFERENCE

1. Abd, B., Andi, S. & Muhpammad, A.I. (2020). Academic self-efficacy as predictor of academic achievement. Journal Pendidikan Indonesia, 9(1), 163-168.
2. Abuh, Y. P. (2021). Influence of Gender on Students' Academic Achievement in Science and Technology Education When Taught Using Innovative Strategies. African Journal of Science Technology Mathematics Engineering (AJSTME), Vol. 7(1): 14-20
3. Abuhamda, E. A. A., Ismail, I. A. and Bsharat, T. R. K. (2021) Understanding quantitative and qualitative research methods: A theoretical perspective for young researchers. International Journal of Research 08(02), 71-89 DOI: 10.2501/ijmr-201-5-070
4. Ackerman, E.S. (2005). Volumetric analysis of Martian Rampart crater lunar planetary. Science, XXXVI.
5. Adu-Gyamfi, K., & Anim-Eduful, B. (2022). Interaction effect of gender across school types on upper-secondary students' development of experimental reasoning in organic qualitative analysis. Journal of Baltic Science Education, 21(3), 351–365. https://doi.org/10.33225/jbse/22.21.351
6. Adu-Gyamfi, K., Ampiah, J. G. & Agyei, D. D. (2020). Participatory teaching and learning approach: A framework for teaching redox reactions at high school level. International Journal of Education and Practice, 8(1), 106–120.
7. Afyusisye, A., & Gakuba, E. (2022). The effect of the chemistry practicals on the academic performance of Ward Secondary School students in Momba District in Tanzania. Journal of Mathematics and Science Teacher, 2(2), em019. https://doi.org/10.29333/mathsciteacher/12397
8. Alkan, F. (2021). Analytical Chemistry Laboratory Qualitative Analysis Process Examination: Links Between Experimental Data and Calculations. Jurnal Ilmiah Peuradeun, 9(3), 719-742. https://doi.org/10.26811/peuradeun.v9i3.663
9. Anim-Eduful, B., & Adoboah Forson, L. (2025). Investigating the factors impeding senior high school chemistry teachers' practical work organisation and its implementation. Eurasian Journal of Science and Environmental Education, 5(2), 19–32. https://doi.org/10.30935/ejsee/16902

10. Anim-Eduful, B., & Adu-Gyamfi, K. (2022). Factors influencing high school chemistry teachers' and students' teaching and learning of organic qualitative analysis: A qualitative study. European Journal of Education Studies, 9(7), 194–219. https://doi.org/10.46827/ejes.v9i7.4378
11. Anim-Eduful, Benjamin and Forson, Lilian Adoboah (2025). Investigating the factors impeding senior high school chemistry teachers' practical work organisation and its implementation. Eurasian Journal of Science and Environmental Education, 5(2), 19-32. https://www.ejsee.com/
12. Aniodoh, H.C.O. & Eze, G. N. (2022). Effects of tutorial, drill and practice modes of computer-assisted instruction on students' attitude and achievement in secondary school chemistry. Journal of Evaluation, 7(1), 33-44.
13. Atomatofa, R. O. (2014). Effects of instructional strategies and gender on Basic-Science students' achievement in Nigeria. Academic Journal of Research Studies in Education, 3, 207–217.
14. Azeez, A. A., Oguhce, J. O., Omananyi, E. O., Kwasi, B. N., Ejeh, B. J. and Toluhi, O. J. (2025). Fostering students' performance and interest in quantitative and qualitative analyses of chemistry practicals through laboratory – based strategy in secondary schools in Kogi State, Nigeria. African journal of Educational Management, Teaching and Entrepreneurship Studies (AJEMATES), 15 (2),
15. Bazie, H., Lemma, B., Workneh, A., & Estifanos, A. (2024). The effect of virtual laboratories on the academic achievement of undergraduate chemistry students: Quasi-experimental study. JMIR Formative Research, 8, e64476. https://doi.org/10.2196/64476
16. Beichumilla, F., Bahati, B. and Kafanabo, E. (2022). Enhancing students' academic achievement, ability, students' acquisition of science Process Skills in chemistry through computer simulations and animations in secondary school in Tanzania. International Journal of Learning, Teaching and Education Research, 21(3)
17. Bete, A. O. (2020). Students' knowledge and process skills in learning grade - 8 chemistry. Journal of Research, Policy and Practice of Teachers and Teacher Education, 10(1), 1-13
18. Chikendu, R. E., & Okoli, C. S. (2025). Effect of hands-on laboratory practical activities on secondary school students' academic achievement in chemistry in Awka Education Zone. SS Journal of Interconnected Education and Life Sciences. South Eastern Journal of Research and Sustainable Development Vol. 18(1), 51-66
19. Chikendu, R. E., & Okoli, C. S. (2025/2026). Effect of hands-on laboratory practical activities on secondary school students' academic achievement in chemistry in Awka Education Zone. SS Journal of Interconnected Education and Life Sciences.
20. Chinda, W. and Achigbe, J. O. (2024). Science Process skils and academic performance of students in cross rivers state colleges. Faculty of National and Apllied Sciences Journal of Mathematics and Science Education, 6 (1), 126-132
21. Efe, A. H. and Abamba, I. E. (2023). Effect of Laboratory Method on students' acquisition of Science Process Skills in Senior Secondary School Chemistry in Delta State, Nigeria. European Journal of Education Studies 10(11); 284 – 299
22. Ekpo, E. B., & Mfam, E. E. (2025). Effect of laboratory activity teaching method on students' interest and academic achievement in chemistry in Ikom Education Zone, Cross River State, Nigeria. International Journal of Research and Innovation in Social Science, 9(8), 5153–5161. https://doi.org/10.47772/IJRISS.2025.908000416
23. Eyisi, D. (2016). The usefulness of qualitative and quantitative approaches and methods in researching problem-solving ability in science education curriculum. Journal of Education and Practice, 7(15), 91-100.
24. Eze, G.N. & Okorie, Q. A. (2019). Effect of cooperative learning strategy on students' achievement in secondary school chemistry. International Journal of Integrated Research in Education (IJIRE), 1(2), 165-171.
25. Ibrahim, M.S., Tairo, A.A., Aminu, I., Isah, I.I., Muhammad, A.A. (2017). Solving the problem of chemistry education in Nigeria: a panacea for national development. American Journal of Heterocyclic Chemistry, 3(4), 42-46.
26. Ijaz, M., Ali, S. & Javaid, M. A. (2023) Investigating Academic Achievement, Chemistry, Laboratory–Centred Instructional Approach, Secondary School. Journal of Educational Research and Social Sciences Review (JERSSR) published by Sir Syed College of Education Katlang Mardan, Pakistan, Vol. 3(3)

27. Iniaghe G. O. A second course in practical chemistry (with notes on laboratory organization) George & Sons press, Ughelli- Delta State 1989.
28. Kelkay, A. D., & Sitotaw, C. (2022). The effect of practical work to enhance ninth-grade achievement in biology class: The case of diaspora secondary school, Ethiopia. Global Journal of Guidance and Counseling in Schools: Current Perspectives, 9(3), 95–105.
29. Konyefa, B.I. & Okigbo, E.C. (2021). Effect of ethnochemistry instructional approach on secondary school students' achievement in chemistry in Bayelsa State. International Journal of Education and Evaluation (IJEE), 7(4), 16-22.
30. Lisney, T.J., Bernnett, M.B. and Collin, S.P. (2007). Volumetric analysis of sensory brain areas indicates onto genetic shift in the relative importance of sensory systems in elasmobranches. Paper No. 14, 7-15.
31. Ndiokwere C. L. & Ukhun M. E. (1999) First Year University Practical Chemistry sylva Publication Ltd Benin city.
32. Odukwe, O. C. & Nwafor, S. C. (2022). Effect of guided-inquiry method on senior secondary school chemistry students' academic achievement in Anambra State, Nigeria. Unizik Journal of Educational Research and Policy Studies, 11(1), 151- 161.
33. Ogunmade, T. O., Olajide, S. S. and Ogunmade, A. C. (2024) Unravelling the transformative impact of laboratory practical approach on students' manipulative skills and academic achievement in senior secondary science. European Journal of Education Studies, Vol.11(2) 245-262
34. Ojokuku G. O. (2010) understanding chemistry for senior secondary schools PRESS-ON-CHEMBOOKS Zaria
35. Okeke, O. J. (2018) effect of gender on mean achievement score of chemistry students taught using Mend Mapping Teaching Strategy (MMTS) in Enugu. International Journal in Physical and Applied Sciences, Vol. 5(8), 32 -51
36. Onyi, I. E., Njoku, Z. C. & Nwafor, S. C. (2022). Efficacy of problem-based learning in promoting high achievement of students in chemistry. Journal of Critical Reviews, 09(01), 49-57.
37. Pilcher, N. & Cortazzi, M. (2023). Qualitative and quantitative methods and approaches across subject fields: implications for research values, assumptions, and practices. Research Gate 2357-3587
38. Sanjito, B. P., & Hyams-Ssekasi, D. (2025). The impact of science practical work on secondary school students' learning outcomes: A meta-analysis. Journal of Research in Science, Mathematics and Technology Education, 8(3), 7–24. https://doi.org/10.31756/jrsmte.832
39. Shana, Z., & Abulibdeh, A. E. (2020). Science practical work and its impact on students' achievement. Journal of Technology and Science Education, 10(2). https://doi.org/10.3926/jotse.888
40. Sibomana, A., Karegeya, C. and Sentongo, J. (2021) Factors Affecting Secondary School Students' Academic Achievements in Chemistry International Journal of Learning, Teaching and Educational Research, Vol. 20 (12) Significant in achievement
41. Tajuddeen, I. M. and Ibrahim M. (2026). Effect of laboratory strategy on academic self-efficacy of chemistry students in secondary schools in Katsina State, Nigeria. Impact International Journals and Publications, 2(ISSUE 3), 156 - 164. https://impactinternationaljournals.com/publications/index.php/ojs/article/view/583
42. Tsobaza, M. K. & Njoku, Z.C. (2021) Effect of Practical Chemistry Teaching Strategies on Students' Acquisition of Practical Skills in Secondary Schools in Kogi State African Journal of Science, Technology & Mathematics Education (AJSTME) ISSN: 2251-0141 Vol. 6 (1), 195 -203
43. Usang, S.P. & Josephine, O.N. (2021). Effect of think-pair-share teaching strategy on secondary school students' achievement in chemistry in Cross River State. Journal of Research & Method in Education, 42-48.
44. Verma, S., Srivastav, Y. and Sirbaiya, A. KK. (026) Laboratory-Based Learning and Academic Achievement in Physics, Chemistry, and Biology Education. SS Journal of Interconnected Education and Life Sciences (SSJIELS), Vol. 02(01) pp. 01-12
45. Walter, U.S. (2021). Effects of practicals and alternative-to-practicals on student's performance in chemistry in Eket local government area of Akwa Ibom State. World Journal of Interactive Research (WJIR), 4(1), 1-12.
46. Wanqing Zhang (2020). Practical Applications of Qualitative and Quantitative Approaches in Interdisciplinary Sciences: A New Perspective. Journal of Interdisciplinary Sciences, 4(2), 43-51.

47. West African Examinations Council (2006). Chief Examiners' Reports on West Africa Senior School Certificate Examinations (Nigeria).
48. West African Examinations Council (2007). Chief Examiners' Reports on West Africa Senior School Certificate Examinations (Nigeria).
49. West African Examinations Council (2022). Chief Examiners' Reports on West Africa Senior School Certificate Examinations (Nigeria).