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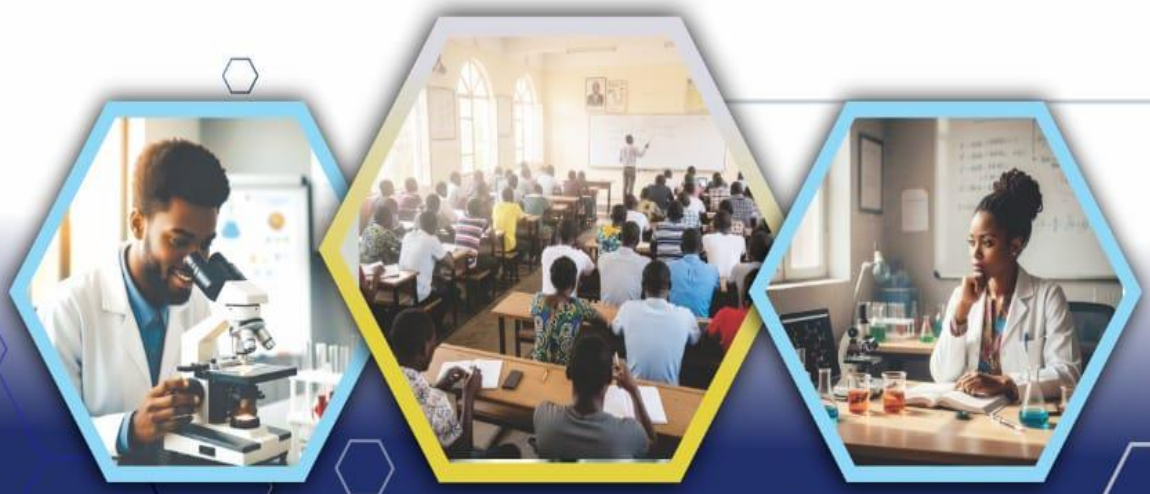

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EFFECTS OF LABORATORY METHOD AND VIDEO-BASED INSTRUCTION ON ACHIEVEMENT IN PRACTICAL CHEMISTRY AMONG SENIOR SECONDARY SCHOOL STUDENTS IN BAUCHI STATE, NIGERIA

[1]Mugana, J., [2]Sulai, E. M., and [3]Kala, M. D.
[1'2'3]Science Education Department, Gombe State University

Corresponding author: muganajeremiah@gmail.com

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Abstract

This study investigated the effect of laboratory method and video-based instruction on performance in practical Chemistry among senior secondary school students in Bauchi state. A total of 126 students were sampled from co-educational senior secondary schools within the three educational zones of Bauchi State using purposive sampling technique. The study used the pre-test, post-test quasi experimental control group design. The instrument used for data collection tagged "Chemistry Practical Test" (CPT) was validated by experts in Science Education, Chemistry and a qualified and experienced secondary school Chemistry teacher. The instrument is also considered reliable with a Pearson product moment correlation coefficient of 0.82 using test-retest method of testing reliability, using data from trail test. Two research questions raised during the study were answered using mean and mean differences and two null hypotheses were tested using Analysis of Covariance (ANCOVA) at $P \leq 0.05$. The major finding from this study include: Students taught practical Chemistry using laboratory method had better achievement than the other groups. It was then recommended that teachers should be encouraged to teach practical Chemistry using laboratory method.

Keywords: Laboratory method, Video-based instruction and Achievement.

Introduction

Chemistry is the branch of science that deals with the study of the composition and properties of matter, changes in matter, the laws and the principles that govern these changes. Chemistry is indispensably significant because it is a major requirement for the study of courses like; food science, medicine, pharmacy, biochemistry, agriculture and engineering (Akram, Ijaz, & Ikram, 2017)). However, without laboratory resources to perform practical classes, Chemistry becomes abstract and difficult to understand (Eilks & Hofstein, 2015; Kenney, 2021). According to Kazeem, Gagdi, Muhammad and Rabiu (2023) Chemistry teachers in Bauchi state applied various teacher-centered conventional teaching methods and strategies like teacher demonstration, lecture and discussion

methods among others for teaching practical chemistry due to lack of laboratory resources. Similarly, findings from the study of Bawa, Mohammed and Gidado (2024) revealed that most secondary schools in Bauchi state used general laboratories for all science subjects and the general laboratory had greater access to biology equipment compared to physics and chemistry equipment which makes it difficult for students to learn practical Chemistry.

Performance of students in Chemistry is the demonstration of students' ability to attain certain level of instructional objectives out of classroom experiences. Performance is also the measure of accomplishment in a specific field of study (Faleye & Adefisoye, 2016). Students when asked to perform a task or create a product are assessed on both the product and the end result of their work. Chief examiner's report of practical Chemistry for; 2019, 2020, 2021, 2022 and 2023 for West African Secondary School Certificate Examination (WASSCE) have consistently reported low performance of students in the examination, suggesting lack of frequent chemistry practical as the source of the low performance, with an average score of between 24 to 28 out of 50 marks from 2011 to 2023 (WAEC, 2024) for practical Chemistry.

Performance of Bauchi State secondary school students from the National Bureau of Statistics 2019 and 2022 and the Federal Ministry of Education, Digest of Education Statistics (2017) show consistently low performance in WASSCE examinations, with the ranking of 31st to 33rd out of 36 States from 2014 to 2022. The National Bureau of Statistics (2019) and (2022) showed that the low performance affects both private and public schools, sometimes students from public schools perform better than those of private schools, other times students from private schools were better. The National Examination Council (NECO, 2023) results show a decline in the average performance of Bauchi state students with 31% of the students failing to get credit pass in Chemistry in 2022 and 2023 (Table 1). There is therefore, the need to change the trend of low students' performance in the state.

Table 1: Performance of Candidates in Chemistry in Bauchi State in SSCE

Year	N	Credit and Above (%)	Pass D7 & E8 (%)	Fail F9 (%)
2023	19, 277	13, 326 (69%)	5, 026 (26%)	832 (5%)
2022	20, 152	13, 925 (69%)	5, 214 (26%)	888 (5%)
2021	20, 904	17, 272 (83%)	3, 149 (15%)	349 (2%)
2020	21, 874	18, 712 (85%)	2, 533 (12%)	529 (3%)
2019	23, 304	18, 789 (81%)	3, 611 (16%)	650 (3%)

Source: psychometric unit of National Examination Council (NECO), 2024.

According to a popular Chinese proverb "What I hear I forget; what I see I remember; what I do I understand" (Simran, 2024). This means that, when it comes to learning, hearing is not as good as seeing, seeing is not as good as experience; and true learning is only evident when experience produces an action. The Laboratory method uses facilities that made it possible for students to see, hear and practice science activities in real life situations. This could mean that, instruction that utilizes the principles of explanation, seeing and participation is essential for learning.

A laboratory practical component that provides hands-on exposure to chemistry-related experimentation is considered essential in chemistry curricula at senior secondary school level. It is learner-centered that involves learners' participation. Typically, skills in practical chemistry are grasped easier by conducting practical in an actual laboratory setting (Eilks & Hofstein, 2015; Kenney, 2021), but when the practical laboratory resources are not available due to high cost of laboratory resources or fear of risk of hazardous nature of some chemicals, then the need to use alternative methods of teaching chemistry practical that will cost less resource or are less hazardous becomes important. Creswell, Loughlin, Coster and (2019) thus have suggested the use of innovative technology pedagogies that can foster secondary school students' performance through adequate instruction in Chemistry.

One of the commonly used technological tools in education is video-based instruction. Video-based instruction has been in the field of teaching and learning for several years (Kohler & Dietrich, 2021), in which television, computers and later mobile devices have grown rapidly around it. Learning through video has become one of the comfortable and speedy instructional approaches in education. As 21st century learners need to be prepared for global citizenship in collaboration with others, especially in the area of practical skills (Ali, 2020). Recent studies have shown that the use of innovative technology like video-based technology improve students' performance in chemistry (Ominowa & Bamidele, 2016; Nwobasi & Nwani, 2020; Mohammed, Chado & Dalhatu, 2021).

Research Questions

The following research questions guided this study:

i. What is the mean achievement score of students taught practical Chemistry using laboratory method, video-based instruction and those taught using conventional method in Secondary Schools in Bauchi State?

ii. What is the mean achievement score of male and female students taught practical Chemistry using laboratory method, video-based instruction and those taught using conventional method in Secondary Schools in Bauchi State?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

HO_1. There is no significant difference in the mean performance scores of students taught practical Chemistry using laboratory method, video-based instruction and those taught using conventional method in secondary schools in Bauchi State.

HO_2. There is no significant difference in the mean performance scores of male and female students taught chemistry practical using laboratory method, video-based instruction and those

taught using conventional method in secondary schools in Bauchi State.

Methodology

The research design used for this study was quasi-experimental research design. The pre-test, post-test of non-equivalent groups were used. The performance of the students was measured by the differences between their post-test and pretest scores. Students taught using Laboratory Method represented by experimental group 1 and those taught using Video-based instruction represented experimental group 2. The Video-based Instruction treatment is an instructional strategy where for this study students used practical Chemistry instructional videos with an interactive simulation; they learned practical Chemistry activities in the videos and performed the activities in the simulation. The control group was represented by traditional teaching without any intervention. The students in both experimental groups and the control group were exposed to pre-test before the administration of treatment. A post-test was administered to the experimental and control groups after six weeks of treatment.

The **sa**mpling was conducted using purposive sampling techniques to ensure subjects chosen included both males and females who had similar background experience and were exposed to similar infrastructure. The sample size for the study was 126 students drawn from a population of 516, 669 senior secondary school students (BME, 2024). Three (3) intact classes of SSII Chemistry students from Bauchi State owned senior secondary schools, within each of the three-education zone represented by one intact class. The sampled schools include; Government Day Secondary School Bayara (used for experiment group II), Government Day Secondary School Udubo (used for experiment group I) and Government Day Secondary School Gabarin Konkyel which was used for control group.

The instrument that was used to collect data is tagged “Chemistry Practical Test (CPT)”. The instrument consisted of sixty (60) multiple-choice assessment items from the

following topics: identification of acid and base, choice of acid-base indicators, determination of titre values, determination of mole ratio, determination of amount and concentrations, using the Senior Secondary School Chemistry curriculum of Nigeria Educational Research and Development Council (NERDC). The instrument was adapted by the researcher from test items that were developed from West African Senior Secondary School Certificate Examination (WASSCE) past questions. CPT was used for pre-test and posttest. The CPT was validated for face and content validity by experts in Science Education and Chemistry. A trial test was conducted to determine the reliability of the CPT using test-retest method. The result from the trial test was analyzed using Pearson Product Moment Correlation Coefficient (PPMCC) and a reliability co-efficient(r) level of 0.82 was obtained.

Results

Research Question 1: What is the mean achievement of students taught practical Chemistry using laboratory method, video-based instruction and students taught using traditional method in senior secondary schools in Bauchi State?

Table 2: Mean and Standard Deviation Pre-test and Post-test of CPT Scores

Group	N	Mean Posttest	SD Posttest	Mean pretest	SD Pretest	Mean Difference
Laboratory method	42	39.93	2.95	9.45	1.75	30.48
Video-based	44	37.02	3.31	8.96	1.81	28.06
Traditional method	40	34.55	3.47	9.18	1.73	25.37

Table 2 reveals that the mean difference between the experimental and control groups is such that students taught practical Chemistry using laboratory method performed better than students taught practical Chemistry using video-based instruction and students taught using video-based instruction performed better than students taught using conventional method.

Research Question 2: What is the mean achievement between male and female students taught practical Chemistry using laboratory method, video-based instruction and those taught using conventional method in senior secondary schools in Bauchi State?

Table 3: Means and Standard Deviation of Pre-test and Post-test of CPT Scores Based on Gender

Group	N	Mean Posttest	SD Posttest	Mean pretest	SD Pretest	Mean Difference
Laboratory male	25	40.84	3.06	9.92	1.55	30.92
Laboratory male	22	35.41	2.20	8.76	1.64	26.65
Traditional male	24	36.17	3.68	8.91	1.74	27.26
Laboratory female	17	38.59	2.24	9.00	1.72	29.59
Video female	22	38.64	2.92	9.25	1.92	29.39
Traditional female	16	32.55	2.70	9.06	1.77	23.49

Table 3 shows that the mean difference between the experimental and control groups is such that male students taught practical Chemistry using laboratory method and conventional method performed better than their female counterparts while female students taught practical Chemistry using video-based instruction performed better than the male students (had better mean difference) and female students taught using video-based instruction performed better than female students taught using conventional method but male students taught using conventional method slightly performed better than male students taught using video-based instruction

Hypothesis One: There is no significant difference in the mean performance scores of students taught practical Chemistry using laboratory method, video-based instruction and those taught using conventional method in senior secondary schools in Bauchi State.

Table 4: Analysis of Covariance of Posttest and Pretest (covariate) of CPT Scores

Source	Type III S of S	df	Mean Square	F	Sig	Partial Eta Square
Corrected model	918.904a	6	153.151	20.301	0.000	0.506
Intercept	9987.770	1	9987.77	1323.94	0.000	0.918
Pretest (covariate)	1.239	1	1.239	0.164	0.686	0.001
Group	608.646	2	304.323	40.340	0.000	0.404
Error	897.731	119	7.544			
Total	176240.00	126				
Corrected Total	1816.635	125				

Table 4 shows that for treatment condition, the calculated F-value of 40.340 was significant at $p<0.05$ given degrees of freedom 2 and 119 ($F_{2, 119} = 40.340$, $p = 0.000$). This means that there was a significant difference in the effect of treatment on performance of chemistry students taught practical Chemistry between the groups. Hence, the null hypothesis HO_1 is rejected. The partial eta squared value of 0.404 shows that treatment had 40.4% contributory effect to the significance.

Hypothesis Two: There is no significant difference in the mean performance scores of male and female students taught practical Chemistry using lab=oratory method, video-based instruction and those taught using conventional method in senior secondary schools in Bauchi State.

Table 5: Analysis of Covariance of CPT Scores Based on Gender

Source	Type III S of S	df	Mean Square	F	Sig	Partial Eta Square
Corrected model	918.904a	6	153.151	20.301	0.000	0.506
Intercept	9987.770	1	9987.77	1323.94	0.000	0.918
Pretest (covariate)	1.239	1	1.239	0.164	0.686	0.001
Gender	30.627	1	30.627	4.060	0.046	0.033
Error	897.731	119	7.544			
Total	176240.00	126				
Corrected Total	1816.635	125				

Table 5 above shows that for gender the calculated F-value of 4.06 was significant at $p<0.05$ given degrees of freedom 1 and 119 ($F1, 119 = 4.06$, $p = 0.046$). This means that there was a significant difference in the effect of gender on performance of chemistry students taught practical Chemistry between the groups. Hence, the null hypothesis HO_2 is rejected. The partial eta squared value of 0.033 showed that treatment had 3.3% contributory effect to the significance.

Discussion of Findings

The findings of this study concur with those of some past studies, such studies include: Samuel and Obikezie (2022) found out that secondary school students taught practical chemistry using laboratory method performed better than those taught using demonstration method. Similarly, Adejo (2021) found out that secondary school students performed better when taught using laboratory method than conventional methods. Ominowa and Bamidele (2016) in their study titled: 'effectiveness of video mediated instruction and classroom demonstration technique on the performance of students and retention in practical chemistry in Akure south local govt of Ondo state' also had findings that agree with the findings of this study, where they reported that students taught practical chemistry using

video-based instruction performed better than those taught using demonstration method. Similarly, Nwobasi and Nwani (2020) found out that videotape instructional strategy improved secondary school students' achievement more than traditional methods.

The findings of this study concur with the findings of Samuel and Obikezie (2022) where they found out that male secondary school students taught practical chemistry using demonstration method performed better than their female counterparts but their study disagreed with the findings when using laboratory method. They found out that female students performed better than their male counterparts. This is in disagreement with the present study, since it was found out that male students performed better than their female counterparts when taught practical chemistry using laboratory method in the present study. Similarly, findings from Ajayi and Ogbeba (2017) disagreed with the findings of this study, as they found out that there is no significant difference between the performance of secondary school students based on gender when taught practical chemistry using laboratory method. Kwuka and Samuel (2017) found out that female students performed better that their male counterpart when taught chemistry using animation video-based instruction in senior secondary schools which agrees with the findings of this study.

Conclusion

Within the limit of the findings of this study, the following conclusion was made: students exposed to laboratory method had better learning outcomes in practical Chemistry than their counterparts exposed to video-based instruction and conventional method. Male students performed better than their female counterparts when exposed to either laboratory or conventional methods but female students performed better than their male counterparts when exposed to video-based instruction.

Recommendation

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

i. Teachers should be encouraged to use laboratory method as the most preferred teaching method for teaching practical Chemistry because it gives better learning outcomes than the other methods.

ii. Teachers should use Video-based instruction to teach practical Chemistry in the absence of laboratory resources, especially when teaching female students.

iii. Students should be encouraged to use available practical Chemistry videos because it improves their learning outcomes

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