Open Journal of Educational Development (OJED)
ISSN: 2734-2050
Article Details:
DOI: 10.52417/ojed.v5i1.714
Article Ref. No.: OJED0501004-550
Volume: 5; Issue: 1, Pages: 32-44 (2024)
Accepted Date: 20th July, 2024

CrossMark
click for updates

Open Journals Nigeria (OJN)
Open Access | Bi-annual | Peer-reviewed
www.openjournalsnigeria.org.ng
editorial@openjournalsnigeria.org.ng

RESEARCH ARTICLE **OJED0501004-550**

INFLUENCE OF KNOWLEDGE OF LABORATORY SKILLS ON STUDENTS' PERFORMANCE IN ACID-BASE TITRATION IN OREDO LGA, EDO STATE.

***Okolafor, O. V. & Omoifo, C. N.**

Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin.

***Corresponding Author Email**: idehaivera@gmail.com; +2347031319103*

ABSTRACT

This study examined the influence of knowledge of laboratory skills, sex, and school ownership on students' performance in acid-base titration in Oredo local Government Area, Edo State. Based on these, four research questions were raised and three were hypothesized and tested at 0.05 alpha level of significance. A causal-comparative (expo-facto) research design was adopted as the research design for the study. The population for the study consists of all Senior Secondary School II chemistry students in public and private secondary schools in Oredo Local Government Area. A sample of three hundred and twenty-six (326) chemistry students were selected for this study through purposive random sampling techniques. An instrument titled 'Laboratory Skills and Titration Performance Test in Acid-base Titration (LSPTT)' was used to collect data from the students in the study. The questionnaire had a reliability coefficient of 0.831 using Cronbach Alpha Statistics while the performance test had a reliability coefficient of 0.760 using Kuder Richardson (KR-20), hence the instrument was deemed reliable. The data collected from the students were analyzed using, mean, standard deviation, and multiple regression. The results from the study showed that observation, reading, and safety skills were predominantly used. The result from the study also showed that laboratory skills contributed to and influenced the performance of the students in acid-based titration, whereas, sex and school ownership did not influence the performance of the students. Based on the findings in the study, it was recommended that the teaching of laboratory skills in practical Chemistry should be prioritized to enable the students to perform successfully in their practical examinations.

Keywords: *Laboratory skills, Student performance, Oredo LGA, LSPTT, Kuder Richardson (KR-20)*

INTRODUCTION

Chemistry is the branch of science that deals with the identification of substances which is composed of matter, the investigation of their properties and reactions, and the use of such reactions to form new substances (Nwafor, 2014). Titration is an important aspect of chemistry that is carried out in the laboratory. Titration is an analytical technique that can be used to analyze purity and content (Salem, 2000). The three manufacturing sectors that heavily rely on titration methods are the food processing sector, chemical manufacturing sector, and pharmaceutical manufacturing sector (Ababio, 2016). The aim of titration methods in the industry is product research and development, quality control, and large-scale production. In the food processing sector, acid or base titration is used to determine the acidity of processed food products, measure the amount of nutrients, and determine the nutrient contents in food products. In the pharmaceutical sector, the titration method supports the preparation of pharmaceutical products and also helps to limit the possible adverse reactions of the body to drugs. This is important because everyone responds differently to pharmaceutical drugs, depending on their age, comorbidity, weight, allergies, immunity, and general biochemistry. In the Cosmetic Industry, titration is used to ensure quality production of cosmetics. Cosmetics manufacturers need to add appropriate concentrations and quantities of chemicals (Ababio, 2016). Therefore, the titration process helps the manufacturers to determine the most suitable base for cosmetics.

In the education sector, acid-base titration is a quantitative analysis carried out in chemistry practicals to determine the concentration of acid (Salem, 2000). It is a hands-on activity with effective knowledge of laboratory skills to enhance conceptual understanding. An acid-base titration is an experimental technique used to acquire information about a solution containing an acid or base, and this type of experiment requires proper adherence to laboratory skills to get the right titers. The laboratory skills employed during acid base titration include organizational, manipulative, measuring, observation, reading, computation, and safety skills (Zhang & Wink, 2021). Organization skills require that you have all your equipment together before you start. For example, make sure you have a calibrated burette, a burette stand, multiple beakers and/or Erlenmeyer flasks, a measured amount of analyte, and a large quantity of titrant before commencement. It also involves keeping benches clean and tidy, rinsing all pipettes and tools and keeping them on one side of the bench, placing common solutions on the other side of the bench, arranging stock solutions on the shelves, laying lab notebook as far as possible from the experimentation area, label all reagents, and set-up equipment. Manipulative skills involve handling the burette and pipette with control and clamping the burette to the retort stand. This practice is often associated with movement, coordination, dexterity, strength, and speed-actions towards the use of instruments (Aktamis and Scar, 2010). Measuring skills are skills required to effectively measure something. It includes measuring liquids with graduated glassware, filling the burette with acid to zero mark, measuring alkaline with a 20 or 25 cm^3 pipette, and dropping the correct amount of indicator into the alkaline. Observation skills involve the ability to notice, analyze, discern, recognize, and recall something. This practice is often associated with mindfulness because it encourages one to be present and aware of the details (Sternberg, 2011). Observation skills in titration entail noticing the colour changes from the start of the titration to the end point. The reading and recording skills are the ability to read, comprehend, interpret, decode, and document data for later use. The reading and recording skills in titration are to ensure that the burette readings are read at eye level meniscus and document the results. Safety skill is knowing how to protect our bodies from scaring, unsafe and dangerous items. It is the ability to handle chemicals, glassware, and equipment safely and adhere to the rules and regulations of the laboratory. Computation skills are the ability to compute readings showing the initial and final readings (Ravishankar and Ladge, 2009). It is expected that students should be able to use the result computed to calculate the average titers, the concentration of acid, and the base. Acid-base titration in secondary school is taught practically in the laboratory.

The knowledge of Laboratory skills in the context of acid-base titration covers the ideas students have about creating hypotheses, pipetting, setting up equipment, standardizing the equipment, measuring, observation, record keeping, ability to sterilize equipment, safety and computation skills (Zhang & Wink, 2021). Gender characteristics and school ownership might affect the way students behave and solve problems. It has been discovered that students exhibit different tendencies towards acid-base titration based on their gender (WAEC, 2020). Male students are more tactful and skillful than the female and thus, can take on challenging problem-solving situations. Also, it has been observed that some school owners pay less attention to revamping the school laboratories and this has deterred many schools from conducting practicals regularly. The nature of chemistry laboratories particularly in public schools in Nigeria can be described as obsolete and below standard. The chemistry laboratory in private schools is not also in perfect condition due to a lack of reagents, apparatus, and skilled personnel for the proper functioning of the laboratory (Afemikhe *et al*., 2014). These challenges in public and private school laboratories tend to have implications for the teaching and learning of practicals. The result is that students' laboratory skills are affected because they would find it rather difficult to develop the appropriate laboratory skills needed to perform chemistry tasks like titration. The WAEC Chief examiner's report about students' performance in acid-base titration has not been encouraging (WAEC, 2020). The report revealed that students showed difficulty in the identification of colour change, inability to take and record readings accurately, poor calculations of results, and they could not attach the correct units to the values calculated. Given the above challenges, could laboratory skills, school ownership, and gender influence the performance of students? Hence, this study was designed to examine the influence of the knowledge of laboratory skills on students' performance in acid-base titration in Oredo Local Government Area, Edo State.

Performance in acid-base titration in chemistry examinations in recent times has been poor (Gero, 2018). In Edo state, many students perform better in chemistry papers 1 and 2 (objectives and Essay) and perform poorly in chemistry paper 3 (practical). In some public schools, students' performance in Chemistry in an internal examination is as bad as 22.2% pass.

WAEC Chief Examiners' Report (2020) showed that the percentage of passes in chemistry practical examinations was low. The report further states that students' poor performance in Chemistry paper 3 (practical) arises from students having difficulty in the identification of colour change, inability to take and record readings accurately, poor calculations of results and they could not attach the correct units to the values calculated. They lost marks for among other reasons like inability to write balanced equations with the right symbols; non-adherence to rubrics; and poor knowledge of basic chemical principles. Schools wait for a few days to practical to coach students on titration, and as a result, students may not be able to familiarise the laboratory skills needed for titration. Practicals do not take place in most schools owing to the lack of reagents in conducting the practical and also, the dilapidated state of most laboratories (Afemikhe *et al*., 2014).

Efforts have been made by science educators, researchers, and stakeholders like STAN to provide solutions to the problems of low performance in chemistry practicals, but there is a paucity of research information on the influence of the knowledge of laboratory skills on students' performance in acid-base titration. Could the poor performance in practical chemistry be a result of the non-exposure of students to laboratory skills? Will gender, and school ownership influence the performance of students? This will be the problem to be resolved in this study. This study attempts to investigate the influence of the knowledge of laboratory skills on students' performance in acid-base titration in Oredo Local Government Area, Edo State.

Research Questions

The following research questions were raised to guide this study:

1. What are the laboratory skills predominantly used by chemistry students in acid-base titration?
2. Is there a difference in the performance of students in acid-base titration based on their knowledge of laboratory skills?
3. Is there a difference in the performance of male and female students in acid-base titration based on their knowledge of laboratory skills?
4. Is there a difference in the contribution of sex, school ownership, and laboratory skills to the performance of students in acid-base titration?

Hypotheses

Three hypotheses were formulated to guide this study:

Ho_1: There is no significant difference in the performance of students in acid-base titration based on their knowledge of laboratory skills

Ho_2: There is no significant difference in the performance of male and female students in acid-base titration based on their knowledge of laboratory skills

Ho_3: There is no significant difference in the contribution of sex, school ownership, and laboratory skills on the performance of students in acid-base titration

MATERIALS AND METHOD

Research Design

This study adopted a causal-comparative (expo-factor) research design. This is so, as the researcher did not manipulate the independent variable because their manifestations have already occurred (Lund, 2022). The independent variable is laboratory skills while the dependent variable is the academic performance of the students.

The population of the Study

The population for the study consists of all the SS2 chemistry students in public and private schools in Oredo Local Government Area, Edo state. There are a total of one hundred and fifty-three (153) public and private secondary schools in Oredo Local Government, Edo state which was made up of thirteen (13) public secondary schools, and one hundred and forty (140) private secondary schools.

Sample and Sampling Techniques

A total of three hundred and twenty-six (326) SS2 chemistry students were purposively randomly sampled. This technique was used to select five (5) public senior secondary schools and fifteen (15) private senior secondary schools from Oredo LGA. This made a total of twenty senior secondary schools selected for the study. All the SS2 chemistry students from each of the twenty (20) senior secondary schools selected for the study constitute the sample size. The choice of SS2 chemistry students is based on the fact that they are already exposed to acid-base titration.

Research Instruments

An instrument was used for the data collection. It is titled 'Laboratory Skills and Performance Test in Titration' (LSPTT). The instrument was developed by the researcher with the assistance of the supervisor. The instrument had three sections. Section A covered the demographic data of the students. Section B is a questionnaire to access the students' knowledge of laboratory skills used in Acid-base titration. This section made use of five out of the seven laboratory skills for acid-base titration. The laboratory skills selected were; measuring, observation, reading, safety, and computation skills. These skills were structured into twenty-five (25) items on a 4-point Likert scale with the numerical values as; strongly agree (SA), Agree (A), disagree (D), and strongly disagree (SD). Section C is a performance test for the calculation of the concentration of acid or base in mol/dm^3. This section consists of two theory questions selected from WAEC GCE and NECO GCE past question papers (2017 and 2021) respectively. Each question has four steps in arriving at the answer. This was used to assess the student's performance in the acid-base titration.

Validity of the Instruments

The instrument was face and content validated. The questions on the instruments elicited responses based on the study. The instrument was validated by the researcher's supervisor, a lecturer from the Department of Science Laboratory Technology, University of Benin, and a secondary school chemistry teacher. This ensured the relevance and clarity of the questions in the instrument, which was used to determine the validity of the instrument.

Reliability of the Instruments

To determine the reliability of the instrument, it was pilot-tested by administering twenty questionnaires to students who will not be part of the study. The data obtained were analyzed using Cronbach alpha and Kuder Richardson (KR-20). The laboratory skills were analysed using Cronbach alpha and a reliability coefficient of 0.831 was obtained. The performance test was analysed using Kuder Richardson (KR-20) and a reliability coefficient of 0.760 was obtained. These values indicated that the instrument was reliable for collecting data for the study.

Methods of Data Collection

The researcher with the help of three (3) research assistants visited the sampled schools. The researcher and the research assistants; worked closely with the chemistry teacher in soliciting the cooperation of the school and students chosen for the study, the help of the chemistry teacher administered the instruments to the respondents in the selected schools. The respondents ticked responses that best describe the skill used in acid-base titration in section B of the instrument, as well as solve step by step in section C of the test instruments the concentration of acid and base in mol/dm^3. The administration and collection of the test instruments was done during chemistry class hour which lasted for 50 minutes. The test instruments were retrieved from the respondents immediately after they were completed and collated for data analysis.

Data coding

The students' knowledge of laboratory skills was rated as follows; strongly agree (SA)=4, Agree (A)=3, disagree (D)=2, and strongly disagree (SD)=1. The cut-off point was set at 2.50. Any response that has a mean score of 2.50 and above was accepted while a response with a mean score of less than 2.50 was rejected. The performance test scored 40 marks.

Methods of Data Analysis

The data collected for the study were analysed using descriptive and inferential statistics. Mean and standard deviation were used to answer research question one. Hypothesis one (Ho_1), investigated that there was no significant difference in the performance of students in acid-base titration based on their knowledge of laboratory skills which was tested using multiple regression. Hypothesis two (Ho_2), investigated that there was no significant difference in the performance of male and female students in acid-base titration based on their knowledge of laboratory skills which was tested using multiple regression analysis. However, hypothesis three (Ho_3) investigated that, there was no significant contribution of laboratory skills and type of school on the performance of students in acid-base titration which was tested using multiple regression analysis. All the hypotheses were tested at a 0.05 significant level.

RESULTS AND DISCUSSION

Laboratory skills are predominantly used by chemistry students in acid-base titration.

The result of this study is presented in the tables below, which addressed the researcher's questions and hypotheses. The analysis and discussion are presented in the order of the research question and hypotheses.

Research Question One: What laboratory skills are predominantly used by chemistry students in acid-base titration?

Table 1: Mean and standard deviation of Measuring skills

S/N	Items	N	Mean	SD	Decision
1	25cm^3 of base is measured using the pipette	326	3.30	0.98	Accepted
2	20cm^3 of base is measured using the burette	326	2.37	1.07	Rejected
3	The burette is filled with acid to zero mark	326	2.94	1.01	Accepted
4	The pipette is filled with acid to 100cm^3 mark	326	2.16	1.10	Rejected
5	2 to 3 drops of indicators are added to the base	326	3.20	0.76	Accepted
	Grand Mean		**2.79**		**Accepted**

Table 1 showed the mean and standard deviation of chemistry students acquainted with measuring skills needed to perform acid-base titration. It can be deduced from the grand mean of 2.79 which is above the criterion mean of 2.50 that the respondents have measuring skill to an acceptable level.

Table 2: Mean and standard deviation of Observation skills

S/N	Items	N	Mean	SD	Decision
6	When Methyl orange is added to weak base, colour changes to yellow	326	3.17	0.77	Accepted
7	When Phenolphthalein is added to strong base, colour changes to pink or bright red	326	2.98	0.94	Accepted
8	The colour of methyl orange is red in an acidic medium	326	3.12	0.95	Accepted
9	Dilute NaOH in a conical flask is colourless	326	3.19	0.96	Accepted
10	The end point in $KMnO_4$ titration is from colourless to light pink	326	3.11	0.82	Accepted
	Grand Mean		**3.11**		**Accepted**

Table 2 shows the mean and standard deviation of chemistry students acquainted with observation skills needed to perform acid-base titration. It can be deduced from the grand mean of 3.11 which is above the criterion mean of 2.50 that the respondents have observation skills to an acceptable level.

Table 3: Mean and standard deviation of Reading skill

S/N	Items	N	Mean	SD	Decision
11	You read endpoint from burette once the colour change is permanent	326	3.29	0.82	Accepted
12	Funnel are removed from the burette before taking reading	326	3.33	0.94	Accepted
13	Indicator changes colour when the pH of its solution is 7	326	3.54	1.02	Accepted
14	Lower meniscus are read in colourless solutions	326	2.79	1.01	Accepted
15	Upper meniscus are read in highly coloured solutions	326	2.82	1.01	Accepted
	Grand Mean		**3.15**		**Accepted**

Table 3 showed the mean and standard deviation of chemistry students acquainted with reading skills needed to perform acid-base titration. It can be deduced from the grand mean of 3.15 which is above the criterion mean of 2.50 that the respondents have the reading skill to an acceptable level.

Table 4: Mean and standard deviation of Safety skill

S/N	Items	N	Mean	SD	Decision
16	Don't handle chemicals safely when titrating	326	1.19	0.62	Accepted
17	I carefully dispose the waste chemicals after completing titration experinments into a sink with running water	326	3.50	0.69	Accepted
18	Take caution in pipetting of the base to avoid swallowing	326	3.60	0.57	Accepted
19	I am aware of emergency procedures for accidental spills	326	3.68	0.51	Accepted
20	Wear your protective wares when titrating	326	3.64	0.65	Accepted
	Grand Mean		**3.12**		**Accepted**

Table 4 shows the mean and standard deviation of chemistry students acquainted with the safety skills needed to perform acid-base titration. It can be deduced from the grand mean of 3.12 which is above the criterion mean of 2.50 that the respondents have safety skills to an acceptable level.

Table 5: Mean and standard deviation of Computation skill

S/N	Items	N	Mean	SD	Decision
21	Only concordant readings are used for averaging of volume of acid used	326	3.12	0.85	Accepted
22	Titration formula is $\frac{(C_A) \times (V_A)}{(C_B) \times (V_B)} = \frac{(na)}{(nb)}$	326	3.03	0.97	Accepted
23	Molarity of the analyte can be calculated using the equation of reaction	326	3.24	0.74	Accepted
24	Only the end point values on the burette is tabulated	326	2.77	1.12	Accepted
25	The end point values from the conical flask is tabulated	326	2.25	1.03	Rejected
	Grand Mean		**2.88**		**Accepted**

Table 5 shows the mean and standard deviation of chemistry students acquainted with the computation skills needed to perform acid-base titration. It can be deduced from the grand mean of 2.88 which is above the criterion mean of 2.50 that the respondents have computation skills to an acceptable level. It can be deduced from Table 1 to Table 5, that observation skills, reading skills, and safety skills were predominantly used by the chemistry students because they had the highest mean scores of 3.11, 3.15, and 3.12 respectively.

The findings of the study revealed that the majority of the chemistry students were more acquitted with observation skills, reading skills, and safety skills as against measuring skills and computation skills. This means that the chemistry students know the basic laboratory skills used for acid-base titration. This aligns with lunette *et.al.* (2007) in their study when they said that using appropriate and basic laboratory skills allows students to conduct, interpret, and report more complete and accurate investigations. This was equally in line with Sternberg (2011); and Ravishankar and Ladage (2009), who both emphasized that there are some basic skills students should be acquitted within chemistry to be creative in practical aspects of intelligence and they include, knowing the right steps to follow to have a quality product at the end of the experiments, knowing what to produce and knowing the material to be used and how to use it, handling chemicals safely with confidence, identifying chemical hazards and learn to assess and control risks associated with chemicals.

The performance of students in acid-base titration based on their knowledge of laboratory skills

Hypothesis one: There is no significant difference in the performance of students in acid-base titration based on their laboratory skills.

Table 6: Multiple Regression testing of the performance of students in acid-base titration based on their Laboratory skills

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30310.485	26	1165.788	8.732	.000[b]
	Residual	39386.512	295	133.514		
	Total	69696.997	321			

a. Dependent Variable: Performance Test

b. Predictors: Laboratory skills

Table 6 shows multiple regression on the performance of chemistry students in acid-base titration based on their laboratory skills in Oredo LGA. It can be seen that the f-value is 8.732 and the alpha level is 0.000 which is less than the set alpha level of 0.05. Thus, the null hypothesis which states that there is no significant difference in the performance of chemistry students in acid-base titration based on their laboratory skills is rejected. This shows that there is a significant difference in the performance of chemistry students in acid-base titration based on their laboratory skills. Thus, chemistry students' performance in acid-base titration is significantly influenced by their Laboratory skills.

The findings in this study revealed that there was a significant difference in the performance of students in acid-base titration based on their laboratory skills. This indicated that laboratory skills influenced the performance of students in acid-base titration. This is in line with the assertion of Chukwuemeka (2008) who found a significant relationship between the utilization of laboratory equipment; laboratory practices and students' performance. Similarly, research work by Festile (2017) on the influence of practical work in the teaching and learning of acids, bases, and neutrals in KwaNobuhele District, Capetown; indicated that practical work with its techniques improved the results of the learners. Another study by Effiong (2011); and Adzape (2015) emphasized that students taught using guided discovery methods as well as using appropriate laboratory practices performed significantly better than those taught with expository and problem-solving methods without appropriate laboratory practices.

Performance of male and female students in acid-base titration based on their knowledge of laboratory skills

Hypothesis two: There is no significant difference in the performance of male and female students in acid-base titration based on their laboratory skills

Table 7: Multiple Regression testing of the performance of male students in acid-base titration based on their laboratory skills

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4472.655	25	178.906	.400	.957[b]
	Residual	3128.860	7	446.980		
	Total	7601.515	32			

a. Dependent Variable: Performance Test

b. Predictors: Male students

Table 7 shows multiple regression testing the performance of male chemistry students in acid-base titration based on their laboratory skills in Oredo LGA. It can be seen that the f-value is 0.400 and the alpha level is 0.957 which is greater than the set alpha level of 0.05. Thus the null hypothesis which states that there is no significant difference in the performance of male students in acid-base titration based on their laboratory skills is accepted. This shows that there is no significant difference in the performance of male students in acid-base titration based on their laboratory skills. Thus, the performance of male students is not influenced by their Laboratory skills.

Table 8: Multiple Regression testing of the performance of female students in acid-base titration based on their laboratory skills

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7441.711	25	297.668	1.726	.063[b]
	Residual	6552.039	38	172.422		
	Total	13993.750	63			

a. Dependent Variable: Performance Test

b. Predictors: Female students

Table 8 shows multiple regression testing of the performance of female students in acid-base titration based on their laboratory skills in Oredo LGA. It can be seen that the f-value is 1.726 and the alpha level is 0.063 which is greater than the set alpha level of 0.05. Thus the null hypothesis which states that there is no significant difference in the performance of female students in acid-base titration based on their laboratory skills is accepted. This shows that there is no significant difference in the performance of female students in acid-base titration based on their laboratory skills. Thus, female students' performance in acid-base titration is not influenced by their Laboratory skills. Hence, Table 7 and Table 8 showed that the performance of male and female chemistry students in acid-base titration was not influenced by their Laboratory skills.

The findings in this study revealed that there was no significant difference in the performance of male and female students based on their knowledge of laboratory skills. This indicated that the performance of chemistry students in acid-base titration was not influenced by their laboratory skills. The findings from this study are in line with Emmanuel *et al.* (2012) opinions showing that male and female students' performance in a test of theoretical knowledge in chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination. They also reported that male and female students' Alternative to Test of Practical Knowledge of Chemistry scores could not significantly predict their MOCK-SSCE mean practical scores. This was equally in line with Frederick (2008) whose result showed that gender does not influence the analytical skill of students and their achievement in mathematics.

The contribution of sex, school ownership, and laboratory skills on the performance of students in acid-base titration

Hypothesis three: There was no significant difference in the contribution of sex, school ownership, and laboratory skills to the performance of students in acid-base titration.

Table 9: Relative contribution of Sex, School ownership, and laboratory skills on the performance of students in acid-base titration

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-20.530	10.655		-1.927	.055
	Sex	2.358	1.741	.075	1.354	.177
	School Ownership	3.124	1.645	.105	1.899	.058
	Laboratory skills	8.704	3.206	.151	2.715	.007

a. Dependent Variable: Performance Test

Table 9 shows the relative contribution of Sex, School ownership, and laboratory skills on the performance of students in acid-base titration in Oredo LGA. It can be seen that the sex t-value is 1.354 and alpha level 1.177 which is greater than the set value of significance of 0.05. Thus, the null hypothesis that there was no significant difference in the contribution of sex on the performance of students in acid-base titration is accepted. Hence, sex did not contribute to the performance of students in acid-base titration. It can be seen that the school ownership t-value is 1.899 and alpha level 0.055 which is greater than the set value of significance of 0.05. Thus, the null hypothesis that there was no significant difference in the contribution of school ownership on the performance of students in acid-base titration is accepted. Hence, school ownership did not contribute to the performance of students in acid-base titration. It can be seen that the laboratory skills t-value is 2.715 and alpha level 0.007 which is less than the set value of significance of 0.05. Thus, the null hypothesis that there was no significant difference in the contribution of laboratory skills on the performance of students in acid-base titration is rejected. Hence, laboratory skills contributed to the performance of students in acid-base titration. Therefore, only one factor (laboratory skills) contributed to the performance of students in acid-base titration.

The findings in this study revealed that there was no significant difference in the contribution of sex and school ownership on the performance of students in acid-base titration. This indicated that sex and school ownership did not make any contribution to the performance of students in acid-base titration. The study also revealed that there was a significant difference in the contribution of laboratory skills to the performance of students in acid-base titration. This indicated that laboratory skills contributed to the performance of students in acid-base titration. The findings of this study corroborate with that of Musibau (2010) as he opined that school ownership, sex, and location of schools had no significant influence on students' academic performance. Another study by Tsobaza and Njoku (2021) stated that gender did not significantly influence students' acquisition of practical skills in public and private secondary schools in Kogi state. Thus, a study by Cecilia *et.al.* (2019) showed that student's different learning styles and preferences were significant to their academic performance. Also, Sternberg (2011); and Carnduff and Reid (2003) stated that basic laboratory skills contribute to students' performance in practicals.

CONCLUSION

It can be concluded that the students were more acquitted with observation skills, reading skills, and safety skills in acid-base titration. This means that they were more knowledgeable on the basic laboratory skills which enables them to act successfully in practical aspects of intelligence. In assessing the influence of laboratory skills, sex, and school ownership in the study, it was observed that laboratory skills significantly influenced the performance of students in acid-base titration. Meanwhile, it was observed that there was no significant difference in the performance of male and female students in acid-base titration based on their Laboratory skills. Likewise, there was no significant difference in the contribution of school ownership and sex to the performance of students in acid-base titration. Thus, the performance of students in acid-base titration in Oredo LGA, Edo state is not significantly based on sex and school ownership but on their laboratory skills.

RECOMMENDATIONS

The following recommendations are made by the researcher based on the findings of the study.

1. The teaching of laboratory skills in practical Chemistry should be prioritized in secondary schools to make the students perform successfully in their practical examinations.
2. Chemistry teachers should be trained and retrained continuously to be knowledgeable in laboratory practices which will enhance the teaching and performance of the students.
3. School owners and education administrators should initiate and encourage policies that promote the employment of qualified chemistry teachers and chemistry laboratory scientists in schools.
4. Government at all levels and school owners should build more chemistry laboratories with complete modern facilities in all secondary schools. This will help teachers and students to build themselves more on the adequate use of the laboratory and acquisition of skills.

REFERENCES

Ababio, O. Y. (2016). *New School Chemistry*. Onisha: Africana First Publishers. 624 pp.

Adzape, J. N. (2015). Effect of chemistry-based puzzles on senior secondary school chemistry students' achievement, retention and interest in chemical periodicity. (Unpublished Ph.D dissertation), Department of Science Education, University of Nigeria Nsukka.

Afemikhe, O. A., Imobekhai, S. Y. & Ogbuanya, T. C. (2014). Assessment of science practical skills for Nigerian secondary schools: Teachers' practices and militating factors, 1-13. Retrieved online from http://www. iaea. info/documents/paper-3fc72cc21. pdf on, 6, 01-23.

Aktamis, H. & E. Scar (2010). The effect of laboratory practical in science teaching course on development of prospective science teachers self-regulation skills. *Procedia Society Behavioural Science*, **2**: 5549-5553.

Carnduff, J. & Reid, N. (2003). Enhancing undergraduate chemistry laboratories, pre-laboratory and post-laboratory exercises, examples and advice. Education Department, Royal Society of Chemistry, Burlington House, Piccadilly, London.

Cecilia, O. B., Cornelius, U. B., Edoho. E. A. & Richard, E. O. (2019). The influence of learning styles on academic performance among science education undergraduates at the University of Calabar. *Educational Research and Reviews,* **14**(17): 618-624.

Chukwuemeka, P. C. (2008), Efficient of Utilization of science process skills among primary science pupils. Paper presentedat the 49th Annual Science Teachers Conference STAN, Nsugbe, August 3-5.

Effiong, V. (2011). Effects of problem solving and guide discovery on students' performance. *Journal of Science Teachers Association of Nigeria*, **26**(2): 59-66.

Emmanuel, E.A., Seraphina, M.K. & Christopher A.O., (2012). Gender dimensions in predictors of students' performance in MOCK-SSCE pratical and theory Chemistry examinations in some Senior Secondary Schools in Nigeria. *Journal of Scientific and Academic Publishing*, **2**(2): 16-22.

Festile, R. M. (2017). 'The influence of pratical work in the teaching and learning of acids, bases and neutrals in Natural science' (Unpublished Msc dissertation), Department of Science Education, UWC Library, University of Cape Town, South Africa. http://hdl.handle.net/11394/5921

Frederick, J. A. (2008). Students' engagement: Potential of concept, state of the Evidence. Review of Educational Research, **74**(1): 59-109.

Gero, S. M. (2018). The Relationship between Students' Achievement in the Theoretical and Practical Aspects of Senior School Certificate Mock Examination in Chemistry, M. Ed Thesis Presented to the Department of Science Education, University of Nigeria, Nsukka.

Lunetta, V., Hofstein, A. & Clough, M. (2007). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. In: Lederman, N. & Abel, S. (Eds.), *Handbook of research on science education* (pp. 393-441). Mahwah, NJ: Lawrence Erlbaum.

Lund, T. (2022). Research problems and hypotheses in empirical research. *Scandinavian Journal of Educational Research*, **66**(7): 1183-1193.

Musibau, A. Y. (2010). The Influence of sex, location and type on students' academic performance. *International Journal of Educational Sciences,* **2**(2): 81-85

Nwafor, O. (2014). The role of chemistry education in National Development. *The international journal of Engineering and Science,* **3**(3): 2319-1805

Ravishankar, L. & Ladage, S. (2009). Laboratory Courses in Organic Chemistry: A Case Study. *Chemistry Education in the ICT Age*. 325-332.

Salem, A., Paula, S. & Dale, H. (2000).'' Titration'' Mathematics and Chemistry Department of Rockhurst University, Connected Curriculum Project, 1999-2000. Published by Duke university. (Salem). Retrieved from https://services.math.duke.edu/education/ccp/index.html.

Sternberg, R. J. (2011). The theory of successful intelligence, In: Sternberg, R.J. and Kaufman, S.B. (eds.), *The Cambridge handbook of intelligence*. Cambridge University Press pp.504-527.

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),* **6**(1): 2251-0141

WAEC, (2020). Feb. 23 -27, Report on May/June and SSCE to the 4th meeting of National Council on Education (NCE), Edo state, Nigeria.

Zhang, H. & Wink, D. J. (2021). Examining an Acid–Base Laboratory Practical Assessment from the Perspective of Evidence-Centered Design. Journal of Chemical Education, **98**(6): 1898-1909.