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## “Impact of Laboratory-Based Teaching Strategy on Students’ Attitudes and Mastery of Chemistry in Katsina Metropolis”, Katsina State, Nigeria

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### Abstract :

*The study sought to determine the impact of laboratory- based teaching strategy on students’ attitude and mastery of chemistry concepts. Two schools were randomly selected and served as experimental and control schools; one hundred and sixty (160) SS II chemistry students were also randomly selected from the population. The same students (160) were divided into two. The first 80 was assigned control group. And the second 80 was assigned experimental group. Pre-test was administered to ascertain the level of compatibility. The experimental group was taught using laboratory approach while control group was taught using lecture method. After the treatment, Chemistry Concept Achievement Test (CCAT) was administered, also Student Attitude Questionnaire (SAQ) was administered to both experimental and control groups to ascertain the change of attitude if any. Four research questions and four hypotheses were raised for the study; the research questions were answered using the data collected and analyzed through the use of SPSS (Statistics Package for Social Sciences). T-tests were used to test the four hypotheses; the tests were designed to determine the impact of laboratory-based teaching strategy on students’ performance. The finding of the study revealed that students taught using laboratory teaching strategy performed better and showed positive attitudes more than the students taught using lecture method. Similarly, there was no significant difference in the mastery of chemistry concept among the male and female students in the experimental group. The finding further revealed that female students within the experimental group demonstrated higher interest than their male counterparts. It was also found that laboratory teaching method was more effective and therefore science teachers should teach students the skills for investigation rather than telling them facts in chemistry.*

### 1. Introduction

Emovon (1999) reflects that chemistry emerged to be recognized as the axial on which developments and progress for many individuals and nations of the world depend. He endorses that chemistry has an important role to play in Nigeria’s national development. For example, in the sphere of industrial development, chemistry plays a significant role in the processes of isolating, extracting, analyzing and synthesizing natural resources for the purpose of transforming matter into useful products for human consumption and utility (Thomas, 1996; Emovon, 1999; Yusuf, 2003). Yusuf (2003) expatiates further that chemistry constitutes one of the science disciplines with well-developed technology that can be applied to explore and exploit natural resources such as petroleum, natural gas and a variety of solid minerals for the benefit of human-kind; similarly, he stresses that the study of chemistry aids students in acquiring manipulative skills while developing a variety of utility skills which are designed to enhance academic learning (Joseph, 2001; Usman, 2003; Yusuf, 2003).

One of the basic requirements of teaching and learning chemistry seriously bears on the provision and use of well-equipped laboratory. In the study of chemistry, students must necessarily be exposed to equipments and facilities during teaching-learning operations; this frame of thought is of paramount importance. It is widely held that students that are subjected to variegated exposures in varied equipments and facilities in laboratory practices possess advanced intellectual development and hence perform better in chemistry examinations (Marceno, 2000; Usman, 2003; Okebeuko, 2006; Njoku, 2007; Sabiru, 2011).

Muhammed (2000) reminds us that in secondary schools, students learn as they operate and manipulate with objects and ideas; in such circumstances, they handle and manipulate the environment in the constant exploitation of it. Yusuf (2003) reveals that learning involves change in behaviour and this development is observed when it is practicalized. He expatiates that it is not how much the teacher teaches that matters but how the learner has been able to learn. He advances that in the field of chemistry learning materials including laboratory equipments should be made available since a number of themes and practical activities may not be understood very clearly without the use of these resources. He discloses further that the use of laboratory equipments and resources enables students to put into practicing their learnings thereby gaining understanding about the concepts being taught in chemistry; this frame of thought makes for better and enhanced performance in Senior Secondary Certificate Examinations in the subject.

Nwadibia (2003) advances that the use of laboratory equipments and resources aid in providing experience to students on how to improve and be more creative in scientific knowledge. He reflects that laboratory work is considered as an instructional facility that a chemistry teacher should utilize in helping students learn what chemistry is and how scientists investigate the world around us. Chemistry educators strongly endorse that the laboratory is an important means of instruction in the subject since late 19<sup>th</sup> century (Joseph, 2001; Yusuf, 2003; Nwadibia, 2003). Joseph (2001) endorses a number of groups of objectives that could be achieved through the employment of laboratory method and activities in chemistry classes as follows: (a) skills mastery including manipulative, organizational and communicative skills; (b) concepts learning and acquisition including the ability that is rooted in formulating hypotheses, building theoretical models and frameworks and constructing categories of phenomena; (c) cognitive development and enhancement which bear on cultivating abilities that impinge on critical thinking, problem-solving, application, analysis and synthesis; (d) provoking the understanding of the nature of chemistry including a contemplation of the following structures in the subject area, namely: (i) the scientific enterprise; (ii) scientists and how they work; (iii) the existence of a multiplicity of scientific methods; (iv) interrelationships between chemistry and technology; and (v) interrelationships prevailing amongst students the various disciplines and sub-disciplines of chemistry; (e) provoking a variety of attitude development amongst students that are rooted in the following: curiosity, interest, risk-taking, objectivity, skepticism, precision, confidence, perseverance, satisfaction, responsibility, consensus and collaboration.

In spite of the important role that chemistry plays in national development, particularly in petrochemical, agricultural and textile manufacturing industries, a number of studies (Akale, 1986; Ajewole, 1991; Ivozou, 1991; Adeyegbe, 1993; Musa, 2000; Joseph, 2001; Njoku, 2005) proved that students' performance in the subject have been persistently poor. Classroom work in chemistry implies different and varied methods of teaching (Yusuf, 2003). Yusuf (2003) further reflects that "to learn chemistry is to do chemistry and doing chemistry by students entails more of providing opportunities for them to interact with the environment, not necessarily exposing these learners to lecture and demonstration methods". Ali (2000), Akpan (1999) and Musa (2000) revealed that some teaching methods are more effective for learning chemistry than others; they confirmed that the laboratory method is far more superior to teaching chemistry than the use of the traditional methods such as lecture and demonstration methods.

On the relevance and appropriateness of the laboratory method in teaching chemistry, Musa (2000) conceptualizes the laboratory as a place designed, organized and managed to help students learn what chemistry is and how scientists carry out investigations. Njoku (2007) reflects that the laboratory method is an essential teaching approach which makes the teaching of chemistry meaningful; it is constituted into a method of instruction in which the teacher presents concepts (chemistry concepts) as well as the procedural instructions for their verification; usually printed laboratory manuals are presented to students with the list of all the laboratory equipment necessary for verifying the chemistry concepts involved. Thus, students are helped to acquire firsthand experience regarding the subject-matter usually obtained from investigation and or experiments. Yusuf (2003) discloses that two procedures or approaches characterize laboratory methods as follows:

(a) Laboratory exercises which consist of activities designed to provide students with practice sessions in designing and operating experiments; and

(b) Experiments which are constituted into procedures designed for the purpose of testing and analyzing chemistry concepts, confirming the known and discovering the unknown.

Yusuf (2003) classifies most laboratory approaches to teaching into five distinct groups, namely: (a) verification and deductive; (b) inductive; (c) scientific oriented processes; (d) technical skills-oriented processes; and (e) exploratory oriented skills. The verification-deduction approach endorses laboratory sessions where students are presented with chemistry concepts and or conceptual frameworks as well as the procedural instructions which are designed to enable them verify the concepts involved. In inductive learning sessions, students are required to examine, group and label specific bits of information to find patterns; by means of these, they are enjoined to develop a set of working hypotheses regarding prospective chemistry concepts they are bound to encounter; this procedure often requires the collection of evidence to verify or refine any hypothesis raised. The scientific oriented processes are constituted into actions which people undertake when doing chemistry; these processes are classified into basic processes and integrated processes (Marceno, 2000; Yusuf, 2003). The basic processes are reflected thus: observing, classifying, communicating, measuring, predicting and inferring; the integrated processes are re-counted as follows: identifying and controlling variables, formulating and testing hypotheses, interpreting data, defining operationally, experimenting, and constructing models.

Zakari (2016) illustrates that a process-oriented guided inquiry learning in chemistry laboratory contains a number of students working in small groups on specially designed materials. These materials supply students with data or information followed by leading questions (from the instructor) that are designed to guide them towards formulation of their own valid conclusions essentially a recapitulation of the scientific method. The instructor serves as a facilitator, observing and periodically addressing individual and classroom-wide needs. A process-oriented guided-inquiry learning constitutes a research-based learning environment where students are actively engaged in mastering course content and in developing essential technical skills by working in self-managed teams based on guided inquiry activities; it is both a classroom and laboratory technique that seeks to simultaneously teach content and key-process skills such as the ability to think analytically and work effectively as part of a collaborative team. Exploratory oriented skills are considered not only in terms of the goal of the general process of education but also in terms of the goal orientation of students when they are engaged in school work. The exploratory laboratory approach depends on the learning outcomes which the chemistry teacher wants students to acquire; the approach demands a number of steps which this teacher needs to adhere to in order to maximize learning; these steps include: (a) pre-laboratory discussion; (b) teacher's directives; and (c) post-laboratory discussion. The pre-laboratory discussion prepares students for laboratory activities; in this circumstance, the chemistry teacher discusses issues and points

concerning the laboratory activities to be executed. The chemistry teacher's directives for laboratory exercises must be explicit; they could be given orally or in written forms or discussed during the pre-laboratory discussions. During post-laboratory discussions, students are expected to present and analyze their data. The confirmation and analysis of data are related to the objectives of a particular unit of lesson. The post-laboratory discussion constitutes an excellent time to broaden students understanding of the curriculum content and processes of chemistry.

### *1.1. Statement of Problem*

Students' attitudes towards the learning of chemistry as a school subject, through laboratory activities, constitute a factor of great magnitude which has attracted the attention of researchers in the subject (Akpan, 1999; Emovon, 1999). Bala (2003) revealed that there prevails a general consensus amongst chemistry theorists and practitioners on the importance of students' attitudes towards laboratory practical lessons in chemistry in schools. Emovon (1999) and Akpan (1999) noted that affective variables are as important as cognitive variables in influencing students' learning outcomes, career choices, and the use of leisure time in chemistry in schools. Thus, the development of students' positive attitudes towards the mastery of chemistry including effective laboratory exposures at schools have become vital if enhanced performance has to be registered in the subject (Bala, 2003; Muhammed, 2000; Musa, 2000; Njoku, 2007; Dahiru, 2013; Kwabena, 2013).

Over the years, results of studies conducted by different scholars and researchers demonstrated students' poor performance in chemistry at Senior Secondary School Certificate Examination (SSSCE) (Ajawole, 1991; Ivozou, 1991; WAEC Report, 1998; Musa, 2000). Njoku (2007) opined that students are not getting sufficient scientific ideas in their learning patterns and approaches to solving problems in chemistry. He adduced a number of reasons to explain the situation as follows: (a) non-availability of instructional materials and resources including requisite textbooks; (b) parents' apathy towards education of their children, particular in science-oriented courses and programmes; (c) over-loaded chemistry curriculum that relegates laboratory pedagogy to the background; (d) lack of clearly defined philosophical framework in chemistry that bear relevance to industrial strategies for national growth; (e) poor classroom management on the part of teachers; and (f) lack of adequate scientific equipments in secondary school laboratories. Adeyegbe (1993), Shuaibu (1993) and Joseph (2001) in their separate findings showed that the most adopted teaching method in many chemistry classrooms in secondary schools is the lecture method. This method, according to these researchers, does not allow for active students' participation in chemistry lessons but rather engenders students' memorization and re-gurgitation of facts and concepts, without enabling them to acquire a mastery and understanding of chemistry concepts. These researchers also noted that, very frequently, these students do not possess the understanding and perspectives of the scientific basis for the relevance of chemistry concepts which are needed for achieving mastery of the knowledge of the curriculum content of the subject.

It has become an established truism that a sufficient mastery of the laboratory approach in chemistry during classroom pedagogy could bring about the improvement of students' performance in the subject (Akpan, 1999; Emovon, 1999; Musa, 2000; Njoku, 2007; Dahiru, 2013; Kwabena, 2013). This study is geared towards establishing the extent to which students are sufficiently committed to achieving mastery in the knowledge of the laboratory approach in classroom work in chemistry in the task of improving their academic performance in the subject at the level of senior secondary school certificate level in Katsina metropolis. This frame of thought has necessitated finding out the impact of the laboratory teaching approach not only on students' mastery in chemistry but also to determine the extent they developed positive attitudes towards knowledge acquisition in the subjects.

### *1.2. Research Objectives*

In reference to the theoretical basis advanced for this study, the following objectives are raised:

- (a) To determine the impact of laboratory-based teaching strategy on students' mastery of chemistry concepts as against the use of lecture method in achieving the same objective.
- (b) To determine the impact of gender on students' mastery of chemistry through pedagogical exposures to the laboratory-based teaching strategy.
- (c) To determine the impact of laboratory-teaching strategy and lecture approach on students' attitudes towards a mastery of chemistry.
- (d) To determine the impact of gender difference on students' interests in the mastery of chemistry through pedagogical exposures to laboratory-based teaching strategy.

### *1.3. Research Questions*

The foregoing objectives prompted the raising of four research questions which the study sought to provide answers for, namely:

- (a) Is there any difference in the mastery of chemistry between students taught using the laboratory-based teaching strategy and those taught through the lecture method?
- (b) Does the mastery of chemistry amongst male and female students differ when taught using laboratory-based teaching strategy?
- (c) What impact has the employment of laboratory-based teaching strategy and lecture approach exerted on Students' attitudes in the mastery of chemistry?
- (d) Is there any differential interest in the mastery of chemistry amongst male and female students exposed to the laboratory-based teaching strategy during classroom pedagogy in the study of the subjects?

#### 1.4. Research Hypotheses

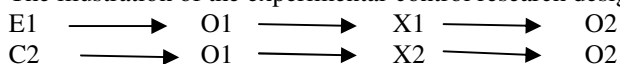
Based on the above research questions, four hypotheses were formulated, namely:

- Ho1: There is no significant difference in the mastery of chemistry amongst students taught using the laboratory-teaching strategy and those taught through lecture method.
- Ho2: There is no significant difference in mastery of chemistry with reference to the mean scores of male and female students taught through the employment of laboratory-based teaching strategy.
- Ho3: There is no significant difference in the attitudes of students exposed to laboratory-based teaching strategy and those taught through lecture method in reference to a mastery of chemistry.
- Ho4: There is no significant difference in the interests of male and female students taught through laboratory-based teaching strategy with reference to demonstrating mastery in chemistry.

#### 1.5. Research Design

The research design was geared at determining whether the use of laboratory-based teaching strategy exerted more positive impact on students' mastery of chemistry in comparison with the employment of lecture method in achieving the same goal. It was a quasi-experimental and control research design as well as a survey. In the context of experimental research, the pre-test and post-test including the experimental and control group structures were used in the study. At the commencement of the study, a pre-test was administered to determine the entry academic behaviours of the students; subsequently, the experimental group was exposed to the treatment; this group was taught using the laboratory-based teaching strategy. As a survey research, this study was geared at analyzing the existing conditions regarding the extent at which senior secondary schools were sufficiently exposed to the laboratory-teaching strategy with the purpose of improving their mastery of the curriculum content enshrined in chemistry at the level of Senior Secondary School Certificate. The survey approach design was employed to enable the researchers have an in-depth and comprehensive information about the problem of the study and, therefore, whether students' attitudes to studying chemistry were affected. The laboratory-based teaching strategy, as employed in this study, is similar to the inquiry method because both of them are activity oriented. In this context, the laboratory method is defined as an approach in which the teacher guided students to discover knowledge by themselves; the practical manuals for this study were adopted from Musa (2000) (See References).

The illustration of the experimental-control research design, as adopted in this study, is rendered in this formula thus:



Where E1= Experimental group

C2= Control group

X1= Laboratory teaching strategy

X2= Lecture teaching strategy

O1= Pre-test

O2= Post-test

The assets of the experimental-control research design derive from the following considerations:

(a) The average gain registered in the experimental and control groups can be compared and subjected to a test of significance of the differences between the mean scores for the two groups; also, the assumption in this design is that uncontrollable events act equally on both groups, so that any gain recorded is expected to be as a result of the treatment applied.

(b) This design assists in demonstrating whether a particular treatment and teaching strategy is superior to the other.

(c) This design can be used to give an indication of gain in understanding of the selected chemistry concepts due to the application of the treatment (Musa, 2000).

#### 1.6. Research Population

The population consists of all SSII chemistry students in all government-owned schools in Katsina Local Government Area of Katsina State, Nigeria. Nine (9) schools featured in the study; two (2) schools were exclusively meant for boys (male) and girls (female) respectively; seven (7) secondary schools were co-educational institutions. The study had a population of one thousand five hundred and ninety-two (1592) SSII chemistry students as displayed on Table 1,

S/N	School	Male Students	Female Students	Total
1.	Government College (DW), Katsina	129	124	253
2.	Government Day S.S., K/Yandaka	75	75	150
3.	Government Day S.S., K/Sauri	73	10	83
4.	Government Day S.S., K/Kaura	115	106	221
5.	Government (P) College, Katsina	100	-	100
6.	Government Girls Col. S.S, Katsina	-	242	242
7.	Government Day S.S., Kambarawa	93	26	119
8.	Katsina College, Katsina	87	89	196
9.	SUNCAIS, Katsina	152	96	248
	<b>TOTAL</b>	<b>824</b>	<b>768</b>	<b>1592</b>

Table 1: Distribution of population according to the secondary schools that featured in the study

### 1.7. Sample and Sampling Procedure

The experimental nature of the study informed the selection of two secondary schools through balloting in order to constitute the experimental and control schools respectively for pilot work. The selection of the study subjects was obtained through random selection from these two schools which were constituted as follows:

- Government College Katsina, which represented the CONTROL SCHOOL and
- Government Day School, Kofar Yandaka, which formed the EXPERIMENTAL SCHOOL.

From the remaining seven schools, one hundred and sixty (160) students were randomly selected for the study. This selection was in conformity with the recommendations of Bala (2003). From each of the pilot study schools, eighty (80) students were randomly selected, consisting of forty (40) males and forty (40) females; this selection was carried out through the use of class registers of the affected SSII students; the selection was also executed through random sampling.

### 1.8. Selection of the Lesson Topic for Teaching

The chemistry topic for this study was: ACID-BASED REACTION (neutralization). This topic was considered because it is fundamental to the study and understanding of chemistry as a subject. The justification for the selection of this topic include the following:

- It forms part of the national chemistry curriculum for SSII students.
- There was the need to maintain continuity and sequence in the normal scheme of work in the sampled schools.
- The concept (acid-base reaction) can be taught using laboratory-based teaching strategy and the lecture method.

### 1.9. Instrumentation

The instrument used for this study was the Chemistry Concepts Achievement Test (CCAT). The instrument comprised of forty (40) multiple choice items. The items were obtained from a collection of West African Examination Council (WAEC), Senior Secondary School Certificate (SSCE) assessment items available in the Science Secondary Schools of Katsina State and from experienced chemistry teachers in the Senior Secondary Schools. These assessment items were used because they possessed the following characteristics:

- their use for research was recommended by the panel of assessment judges of the West African Examinations Council (WAEC);
- the items generally possessed a facility indices ranging between 0.30 to 0.70; the selected items also constitute a reflection of the four (4) cognitive levels of Bloom's Taxonomy for the cognitive domain (Bloom, 1960), as rendered by Musa (2000) thus;
  - Level A: comprises of functional information, which demands mainly the ability to recall information.
  - Level B: creates for a demonstration of "understanding", which calls for a demonstration of the ability to use knowledge in a familiar situation.
  - Level C: creates forums for "knowledge application", which involves the ability to select appropriate knowledge and apply it to a problem situation.
  - Level D: creates forums for higher processes of learning which call for a display of ability that requires "analysis" and "evaluation".

Cognitive Levels	A	B	C	D	Total
Test Items	15	10	10	5	40

Table 2: Demonstrates a distribution of the forty (40) test items, as classified by Bloom (1986) thus:

The adaptation of the items of the instrument was made by the researchers after consultations with chemistry lecturers in the Chemistry Department of Umaru Musa Yar'adua University, Katsina; the chemistry teachers of the secondary schools that featured in the research were also consulted because of their vast experience for effective handling of chemistry lessons in these institutions. Five lesson plans whose topics were derived from variations of the acid-base reaction concept (neutralization) were put in-place for

teaching the SSII students that featured in the research. The experiment group was taught using the laboratory-based teaching strategy while the control group was taught using the lecture method (See Appendix).

Also, thirty (30) items questionnaire instrument titled "Students' Attitude Questionnaire in Chemistry" was also administered to both the experimental and control groups after the treatment. This instrument was adapted from Osborne's et al (2003) "Attitudes toward science: A review of the literature and its implications"

#### Pilot Study Report

A pilot study was conducted at Katsina College, Katsina to determine the following:

- i. facility index of the text items of the research instrument;
- ii. validity and reliability of the two instruments used in the study ("Chemistry Concepts Achievement Test" and "Students' Attitude Questionnaire in Chemistry").

The pilot study revealed that four items of the test instrument were found to be difficult: three of the items were found to be quite simple. These items were replaced with more suitable items, which finally constituted the test instrument with facility indices ranging between 0.30 to 0.70 (See appendix).

The forty items "Chemistry Concept Achievement Test" were given to four experienced chemistry teachers of senior secondary schools to examine the suitability of the items that featured in the test instrument. The items were, however, revised based on the experts' recommendation in terms of clarity and cognitive demands. The 30-items questionnaire instrument on "Students' Attitudes to Chemistry" were also given to experts for validation. Their recommendations, suggestions and observations were noted and reflected in the questionnaire.

The forty (40) students that featured in the Pilot study were tested and re-tested to determine the reliability and dependability of the designed "Chemistry Concept Achievement Test" which consisted of 40 items as well as the 30-item questionnaire on "Chemistry Students' Attitudes". The tests were carried out within an interval of two weeks; the first instrument (Chemistry Concept Achievement Test) yielded a reliability coefficient of 0.693 while the second instrument (Chemistry Attitude Questionnaire) yielded a reliability coefficient of 0.997. These coefficients are demonstrated on Table 3 and 4.

Test Type	N	Mean	SD	Pearson Correlation
Test	40	70.9	3.55	0.693
Re-test	40	64.3	3.57	

Table 3: Test-Re-test Chemistry Concept Achievement Test (CCAT)

Test Type	N	Mean	SD	Pearson Correlation
Test	40	59.2	13.03	0.997
Re-test	40	69.9	13.08	

Table 4: Test-Re-test Attitude Questionnaire

A Pearson product correlation was run to determine the relationship between test values and re-test values derived from the test administered to students in respect of their performance in chemistry test: the scores were analyzed using Statistical Package for Social Science (SPSS). The data showed no violation of normality and the result revealed a positive correlation between the test and re-test scores obtained. Similarly, a Pearson Product Correlation was employed to determine the relationship between the two-administered test (test and re-test) given to students on their attitudes towards the laboratory-based teaching strategy in classroom pedagogy in chemistry. The data revealed a strong positive correlation (Table 4) between the two administered questionnaire instruments, which was statistically significant ( $r=0.997$ ).

#### 1.10. Treatment Procedure

The researchers conducted the teaching and laboratory activities to both the experimental and control groups with strict adherence to the lesson plan prepared by the researchers (See appendix). The contact sessions for both the experimental and control groups lasted for eight (8) weeks. The first week was used for orientation, where the researchers and the students got themselves familiarized. There were six weeks of teaching in both the experimental and control groups. The laboratory mode of instruction was adopted for the experimental control while lecture method featured in teaching the control group: the same selected concepts were employed in teaching the two groups of students.

In regard to the employment of the laboratory-teaching strategy in this research, students were arranged in groups of four and were provided with a laboratory manual, equipment as well as test questions. The students carried out the practical activities under the guidance of a teacher. At the end of the practical sessions, the performances of students were assessed and corrections were also affected.

In reference to the employment of the lecture method, the researchers conducted lessons of forty minutes per period for six (6) weeks using a variety of teaching aids. For example, teaching aids such as acid, base, salt and water were extensively used. At the end of each lesson, students were allowed to ask questions: they were also subjected to test questions at the end of each lesson, and these were evaluated.

### 1.11. Procedure for Data Collection

After the treatment, the researchers administered post-test Chemistry Concept Achievement Test (CCAT) to both experimental and control groups. The data collected were analyzed accordingly, after the administration of the CCAT. The Students Attitude Questionnaire (SAQ) was also administered to both experimental and control groups to ascertain students' level of attitudinal change.

In this study, the written laboratory reports by students were adequately used to evaluate their laboratory work. For example, the following key aspects of the reports were put in-place namely: (a) correct reporting of practical procedures: (b) steps taken for precision and accuracy of recording data: and (c) recording of possible conclusion drawn from the results obtained. These were considered as main points to which marks were awarded during the grading process. The results of the treatment were withheld from the control group which received the same chemistry instruction as the experimental group using the lecture method. The teachings in both experimental and control groups were conducted by the researchers.

A post-test was administered at the end of the treatment. A pre-test was, however, given before the commencement of the contact sessions to the two groups. The results of the pre-tests of the group are demonstrated in the appendix. The pre-test comprised of the Chemistry Concept Achievement Test (CCAT) which was also used as the post-test at the end of the treatment.

### 1.12. Procedure for Data Analysis

Students' responses to the CCAT were considered using the marking scheme shown in Appendix B. However, each correct response to any of the items of the instrument was scored 2.5 marks: the total scores for all the items of the instrument was 100 marks. The probability level  $p < 0.05$  was used for retaining or rejecting the stated hypotheses. The scores obtained from CCAT provided the data for testing hypotheses 1 and 2. The data obtained from students' attitude questionnaire (SAQ) provided the data for testing hypotheses 3 and 4. The means and standard deviations derived from students' post-test scores were used in answering the research questions.

### 1.13. Presentation of Results, Data Analysis and Discussion

This research was designed to find out the impact of laboratory-based instructional strategy on students' mastery and attitudes in chemistry. The analysis carried out involved statistical testing of the hypotheses using SPSS package. The level of significance adopted is  $p > 0.05$ . This level of significance formed the basis for retaining or rejecting each of the null hypothesis stated.

Hypothesis 1: There is no significant difference in the mastery of chemistry concepts between students taught using laboratory-based teaching strategy and those taught using lecture method. The data raised for this hypothesis is presented on Table 5

Group	X	SD	DF	t-value	P	Remarks
Experimental	80	67.73	7.67	158	14.36	0.000
Control	80	50.65	7.37			

Table 5

In Table 5 t-test was conducted for independent samples to compare differences in students' mastery of chemistry concepts, between students taught using laboratory-based teaching strategy and those taught through the use of lecture method. The Table revealed that when students we taught through the laboratory-based teaching strategy, they demonstrated significant mastery of chemistry concepts more than those taught through lecture method; this was confirmed by the post-test results. This revealed that there was significant difference; the null hypothesis was, therefore, rejected. This result confirms the investigations of Musa (2011) on the efficacy of laboratory-teaching strategy in enhancing students' academic performance in chemistry.

Research Question One states: Is there any difference in the mastery of chemistry concepts between students taught through laboratory-teaching strategy and those taught through the lecture method?

Table 5 reveals that there is statistical difference between the mean score and standard deviation of the experimental and control groups. The experimental group registered a mean score of 67.73 and a standard deviation of 7.67 while the control group has a mean score of 50.65 and a standard deviation of 7.37.

Hypothesis Two: There is no significant difference between the mean scores of male and female students taught chemistry through the use of laboratory-based teaching strategy.

Group	N	X	DF	t-value	P	Remarks
Male	40	69.33	7.67	78	0.62	Not Significant
Female	40	69.23	7.95			

Table 6: Displays the analysis of male and female students taught through the use of laboratory-based teaching strategy

In Table 6, t-test for independent samples was conducted to compare difference in students' mastery of chemistry concepts amongst male or female students taught using laboratory-based teaching strategy. In the Table, p-value is 0.62, suggesting that gender difference does not have effect on students' mastery of chemistry. The Table reveals that laboratory-teaching strategy approach is gender-friendly; therefore, the foregoing hypothesis is rejected. This result supports the findings of Stark and Gray (1999) on the influence of laboratory approach in teaching chemistry amongst students in schools. The findings showed that the initial gap between male and female subjects was bridged using laboratory-teaching strategy in classroom work.

Research Question 2 states: Does the mastery of chemistry concepts between male and female students differ significantly when they are taught through the use of laboratory-teaching strategy.

In regard to the above research question, Table 6 indicates that the means and standard deviations of both male and female students taught through the use of the laboratory-teaching strategy are comparatively the same; their means are 69.33 and 69.23 respectively, while their standard deviations are 7.96 and 7.95 respectively.

Hypothesis three: There is no significant difference in the attitudes of students in respect of those that were exposed to the laboratory-teaching strategy and those taught through the use of lecture method in the course of mastering chemistry concepts.

Group	N	X	DF	t-value	P		Remarks
Experimental	80	129.31	9.94	158	42.63	0.000	Significant
Control	80	62.31	9.94				

Table7: Displays of students' attitudes to mastering chemistry concepts among the experimental and control groups

In Table 7, t-test for independent samples was conducted to compare the difference in students' attitudes towards mastering chemistry through the use of laboratory-teaching strategy and lecture method respectively. The Table reveals that there is statistical difference between students exposed to the laboratory-based teaching strategy and those taught through the use of the lecture method. The results indicate that the use of laboratory-teaching strategy exerts influence on student's attitudes towards a mastery of chemistry concepts; the use of the laboratory-teaching methods exerts positive impact on students' mastery of chemistry concepts when compared to the use of lecture method. The third null hypothesis is therefore rejected. This finding is in consonance with the research revelation of Johnston (1999) who endorsed that laboratory teaching method motivates and arouses students' interests towards a mastery of concepts.

Research Question three states: To what extent has any of the teaching strategies (lecture method and laboratory-based strategy) exerted more positive attitudes on students' mastery of chemistry concepts?

Table 7 discloses that the experimental group demonstrates a mean score of 129.31 while the control group records 62.31: this result demonstrates that the use of laboratory-teaching strategy exerts more positively on students' attitudes towards a mastery of chemistry concepts when compared to the use of lecture method.

Hypothesis Four: There is no significant difference in the attitudes of male and female students towards a mastery of chemistry concepts through the use of laboratory-based teaching strategy.

Group	N	SD	DF	t-value	P	Remarks
Male	40	125.48	10.81	78	3.7	Not Significant
Female	40	133.15	11.40			

Table 8: Displays an analysis of male and female student's attitudes towards a mastery of chemistry concepts by way of exposures to the use of laboratory teaching strategy

In Table 8, t-test for independent samples was executed to determine the difference amongst male and female students' attitudes towards the use of laboratory-teaching strategy in the mastery of chemistry concepts. The result reveals a significant difference amongst the two groups: it indicates that the female students who were taught through laboratory-teaching strategy showed more positive attitude and interest towards learning chemistry concepts than the male students who were taught through the use of the same method. The fourth hypothesis is rejected. This results is in consonance with the findings of Stark and Gray (1999) that the use of the process-based instructional strategy tends to have stimulated more gains in the female subjects than their male counterparts.

Research Question Four states: To what extent does there exist a difference amongst male and female students in their interest regarding their exposures to laboratory-teaching strategy in the mastery of chemistry concepts.

Table 8, discloses that the females' interests are more than that of their male counterparts: the females registered a mean of 133.15 while the males recorded 125.48.

## 2. Discussion of Results

The purpose of this research was to determine the impact of the employment of laboratory-based teaching strategy on students' mastery of chemistry concepts when compared with the use of lecture method in achieving the same design during classroom pedagogy. The data for the study was derived from students' scores registered in the Chemistry Concept Achievement Test (CCAT) and the 30-items questionnaire instrument titled "Students' Attitude Questionnaire". The data that emanated from these scores formed the basis for analyzing the hypotheses and the research questions raised in the study.

The analysis of the results that featured in the study revealed that the experimental group registered a mean score of 67.7 and therefore performed significantly better than the control group with a mean score of 50.7. The findings of this study suggest that the laboratory-teaching strategy is more effective than the lecture method in the mastery of chemistry concepts: this finding confirmed the revelation of Harry and Al-felah (1983) in Yusuf (2003). The finding further revealed that a comparison of the academic achievements of students taught through the laboratory-teaching strategy and those of their counterparts taught through the lecture method indicated that students exposed to the laboratory-based method demonstrated higher chemistry achievement. These findings also affirm the



assertion of Zitoon and Al-zambi (1980) in Kwabena (2013) that the laboratory-based method is more effective than the traditional method in the task of developing the skill of scientific thinking amongst students.

The findings also revealed that there was no significant difference at  $p=0.05$  in the performance of male and female students when taught using the laboratory-teaching strategy; the method is found to be effective for both female and male students. This finding is in consonance with that of Tobin (1989) in Musa (2000) who observed that there was no significant difference in the participation of males and females in science of which chemistry is one of them.

In the analysis of the scores registered by the subjects regarding their attitudes towards a mastery of chemistry concepts, the experimental group registered a higher mean score of 129.3 when compared with that of the control group with just 62.3; the experimental group that was exposed to the laboratory-based teaching strategy developed more interests and exhibited more positive attitude towards a mastery of chemistry concepts than the control group that was taught using lecture method. This confirms the revelation of Bala (2003) who disclosed that effective use of the laboratory approach encourages a development of positive attitudes amongst students for effective learning of chemistry

### 3. Conclusion

The study revealed that the use of laboratory-based teaching strategy is more effective than the use of lecture method in teaching chemistry. The use of the laboratory-teaching strategy creates and enhances students' motivation, interests and achievement; this development creates forums for effective teaching-learning in chemistry. This revelation is in conformity with the findings of Odubumi and Balogun (1991) in Kwabena (2013) that asserted that low achievement students, using the laboratory method performed better than their counterparts who were exposed to lecture method during classroom pedagogy. The use of the laboratory teaching method is designed to engage students actively in the learning process; it promotes collaborative learning and encourages students to acquire scientific skills and promoted positive attitudes towards a mastery of chemistry concepts amongst students.

### 4. References

- i. Adeyegbe, S.O. (1993). Continuous assessment and practical work in chemistry teaching: A plea for pragmatism. *Journal of Chemistry Teachers Association of Nigeria*, 22(2), 43-48.
- ii. Ajewole, A. G. (1991). Effect of discovery and expository instructional methods on the attitudes of students to Biology. *Journal of Research in Science Teaching*, 28(5) 140-409.
- iii. Akale, C. (1986). The development and use of an instrument to assess students' attitude to the study of chemistry. *Internal Journal of Chemistry Education*, 22(8), 833-845.
- iv. Akapan, E. U. U. (1999). Towards evaluating chemistry laboratory practices: A survey in Plateau State secondary schools in evaluating chemistry, technology and mathematics education. 40<sup>th</sup> Annual Conference Proceedings of Science Teachers' Association of Nigeria. (STAN), 117-122.
- v. Ali, A. (1998). Discovery and expository task presentation among Nigerian elementary mathematics pupils. *Abacus* 16, 99, 1-25.
- vi. Bala, M. (2003). The relevance of laboratory teaching methods: A dissertation for Ph. D submitted to the Department of Education, Usman Danfodia University, Sokoto (Unpublished).
- vii. Bello, S. A. (2001). Trends in science education and the further of science curriculum in Nigeria, *Journal of STAN*, 2(1), 75-95.
- viii. Emovon, N. P. (1999). Analysis of the enrolment and performance in the hardchemistry in West African School Certificate in the 1960's. 28<sup>th</sup> Annual Conference Proceedings of the Chemistry Teachers' Association of the Nigeria, 25-32.
- ix. Hofstein, A. (2005). The laboratory in science education: the state of the art. *Chemistry Education Research and Practice*, 8(2), 105-107.
- x. Isah, I. Z. (2016). Influence of laboratory concept approach on student's attitudes and mastery of chemistry in Katsina metropolis (Unpublished M.ED. Dissertation, Umaru Musa Yar'adua University, Katsina, Katsina State.
- xi. Ivozou, L. (1991). The merits of continuous assessment and formal examination in practical work, *Journal of Biological Education*, 6, 314-318.
- xii. Johnstone, A. H. (1997). Chemistry teaching: Chemistry or alchemy? *Journal of Chemical Education*, 74, 262-268.
- xiii. Joseph, T. S. (2001). Forth-coming:xxx Does practical work actually work? A study of the effectiveness of practical work as a teaching method in school chemistry. *International Journal of Science Education*, 30(14) 1998-2000.
- xiv. Kwabena, B. O. (2013). Improving senior high school students' performance in chemistry using laboratory-based method against lecture method in school. A dissertation presented to the Department of Science Education (M. ED Science), Wiebna University (Unpublished).
- xv. Marceno, N. U. (2000). The Influence of computer-based physics teaching on the success of students and modern mathematics and science programmes applied in Turkey in the years between 1962 and 1985. Ankara: Gazi University, Institute of Science (Unpublished Master Thesis).
- xvi. Muhammed, R. (2000). An empirical investigation to determine the relative effectiveness of discovery, laboratory and expository methods of teaching chemistry concepts. *Journal of Research in chemistry Teaching*. 20(3), 201-209.

- xvii. Musa, B. (2000). The relative effectiveness of laboratory teaching method for enhancing academic performance in Chemistry among senior secondary school students. A Thesis for Master Degree in Science Education, Ahmadu Bello University, Zaria. (Unpublished).
- xviii. Njoku, Z. C. (2007). Comparison of students' achievement in the three categories of questions in SSCE practical chemistry examination. *Journal of Chemistry Teachers' Association of Nigeria*, 42 (1&2), 67-72.
- xix. Nwadiya, S. M. (2003). The influence of different teaching methods in teaching physics on students' success. *The Journal of Gazi Education Faculty*, 19(3), 79-88.
- xx. Odubunmi, O. and Balogun, T. A. (1991). The effect of laboratory and lecture teaching method on cognitive achievement in integrated chemistry, *Journal of Research in Chemistry Teaching*, 3, 213-224.
- xxi. Okebukola, P. A. (2006). Students' performance in practical chemistry: A study of some related factors. *Journal of Research in Science Teaching*, 24(2), 119-126.
- xxii. Sabiru, D. Y. (2011). Effectiveness of students' centered learning as a method for teaching chemistry concepts in senior secondary schools, *UMYU Journal of Educational Research*, Vol. 3, No.1, 177-182.
- xxiii. Shuaibu, B. (1993). A survey of different methods of teaching science in selected secondary in Zaria and environs. An Unpublished M.Ed. Thesis, ABU, Zaria.
- xxiv. Stark, R., and Gray, D. (1999). Gender preference in learning science. *International Journal of Science Education*, 21(6) 633-643.
- xxv. Thomas, P. C. (2000). Inquiry-based methods of instruction in chemistry. Retrieved on 8<sup>th</sup> August, 2011 from [http://spacegrant-nmsu.edu/NMSU/2001/d\\_alexander.pdf](http://spacegrant-nmsu.edu/NMSU/2001/d_alexander.pdf).
- xxvi. Tambuwal, N.P. (1991). The educational effectiveness of filmed experiments in high school chemical education. *Journal of Chemical Education*, 53, 518-520.
- xxvii. Usman, M. (2003). The influence of computer-based physics teaching on the success of students in modern mathematics and chemistry programmes applied in Turkey in the years between 1962 and 1985. Gazi University, Institute of Chemistry (Unpublished Master Thesis).
- xxviii. Yusuf, T. Y. (2003). *Chemistry teaching in Nigeria*. Zaria: Atoto Press Limited.