EFFECTS OF VIRTUAL LABORATORY ON ACHIEVEMENT LEVELS AND GENDER OF SECONDARY SCHOOL CHEMISTRY STUDENTS IN INDIVIDUALIZED AND COLLABORATIVE SETTINGS IN MINNA, NIGERIA

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ABSTRACT
The study investigated the effects of virtual laboratory on the achievement levels and gender of secondary school chemistry students in individualized and collaborative settings in Minna, Nigeria. Five hypotheses were formulated and tested at 0.05 level of significance. 120 Senior Secondary Class Two (SS II) chemistry Students were stratified along gender and achievement levels. Sixty students (male, n = 30 & female, n = 30) were randomly selected from each school. The study employed a quasi-experimental involving pretest, posttest, and control group design. A validated Chemistry Achievement Test (CAT) made-up of twenty multiple-choice items was used for data collection. A reliability coefficient of 0.91 was obtained from the pilot test using Kuder Richardson (KR-20). Mean and ANCOVA were employed in analyzing the data. The results showed that: (i) Students exposed to chemistry virtual laboratory package in collaborative learning setting outperformed their counterparts in individualized setting; (ii) there was significant difference in the mean achievement scores of male and female students taught using Chemistry using Virtual Laboratory in Individualized Setting; (iii) There was no significant difference in the mean achievement scores of male and female students taught chemistry using virtual laboratory in collaborative learning setting; (iv) there was no significant difference in the mean achievement scores of high, medium and low students taught using chemistry virtual laboratory in collaborative, and individualized settings respectively. Based on these findings, it was recommended that the use of virtual laboratory instruction in collaborative setting should be encouraged in teaching chemistry at senior secondary schools in Nigeria.
Keyword: Virtual Laboratory, Chemistry, Achievement Levels, Gender, Individualized Learning, Collaborative Learning

INTRODUCTION

Science and technology play a vital role in the development of any nation. They are the predictors of success and development of any nation's economy. Chemistry occupies a central position among all science subjects. It is a core subject for Medical science, Textile science, Agriculture science, Synthetic industry, Printing technology, Pharmacy, Chemical technology (Jegede, 2007). Research evidences have proved that chemistry's contribution to quality of life and nation building is enormous in all aspects of human endeavour (Olorukooba, 2007; Olorundare, 2011). Probably that is why the developed nations recognized the relevance of chemistry in their national economy. It was based on this fact that the Federal Republic of Nigeria through her National Policy on Education made chemistry a compulsory science subject at secondary school level (FRN, 2013). Reiterating the importance of chemistry, Ezenwa (2005) opined that no nation can be scientifically and technologically developed without adequate level of chemistry education.

In spite of the importance of chemistry as a requirement for many specialized science and technology courses at the universities, polytechnics and colleges of education, there has not been remarkable improvements in the students' performance in the subjects at senior secondary school level in Nigeria (NECO, 2015; WAEC, 2015). The chief examiners' reported that the percentage of students that passed chemistry at credit level and above (A1-C6) was consistently less than 50% for the past five years (WAEC, 2015) in Nigeria. Students' poor performance in chemistry was noted in the NECO and WAEC Chief Examiners' Reports. This poor performance in chemistry is very disturbing and if not checked, may jeopardize the placement chances of students in tertiary institutions, not only in chemistry education but also in other chemistry related disciplines. This has serious implications for Nigeria economy, security, and manpower development.

Consequently, efforts have continuously been made to improve on chemistry teaching and learning especially at the senior secondary level so as to ensure a sound foundation for future studies. Researchers such as Adesoji and Fisuyi (2001), Evans and Leinhardt (2008), Olorukooba (2007), Olorundare (2014) and many others have identified class size, poor student background in science, teacher' exposure, poor instructional methods, negative attitude of teachers, in adequate / lack of laboratory facilities as factors contributing to students' poor performance in chemistry.

Students' failure rate in chemistry has been traced to lack of facilities for chemistry practical in schools. In fact, Njoku (2007), Okebukola (1999) and Olorundare (2014) lamented that students' failure in Chemistry at Secondary School Certificate Examination (SSCE) can be traced to their poor performance in the practical which can frequently attributed to the lack of laboratory practice (Yang & Heh, 2007). Few students with good performance do so by rote memorization of facts without transforming the language and materials teachers use in Chemistry practical into meaningful representations.

Previous studies have reported that chemistry practical cannot be properly embedded into traditional chemistry courses for various reasons, such as: safety concerns, lack of self-confidence, an excessive amount of time and effort required to conduct accurate experiments and many others (Okebukola, 2006; Njoku, 2007; Obrentz, 2012). Nonetheless, it is possible to overcome these obstacles via technology-base alternatives (Okon, Kaliszan, Lawenda, Stoklosa, Rajtar, Meyer, & Stroinski, 2006).

An alternative learning environment, called a virtual laboratory, can help to make this crucial educational application available to students (Kumar, Pakala, Ragade, & Wong, 1998; Shin, Yoon, Park & Lee, 2000; Grob, 2002; SAVVIS, 2010; Jeschke, Richter, & Zorn, 2010). Virtual laboratory is a learning environment in which students convert their theoretical knowledge into practical knowledge by conducting experiments (Woodfield, 2005). Virtual laboratories simulate a real laboratory environment and processes. They provide students with meaningful virtual experiences and present important concepts, principles, and processes. By means of virtual laboratories, students have the opportunity of repeating any incorrect experiment or to deepen the intended experiences. Moreover, the interactive nature of such teaching methods offers a clear and enjoyable learning environment (Ardac & Akaygun, 2004, Jeschke, Richter, & Zorn, 2010).

A virtual laboratory may sometimes be a preferable alternative, or simply a supportive learning environment, to real laboratories. It provides students with opportunities such as enriching their learning experiences; conducting experiments as if they were in real laboratories; and improving their experiment related skills such as manipulating materials and equipment, collecting data, completing experiment process in an interactive way (with boundless supplies), and preparing experiment reports (Subramanian & Marsic, 2001). Researchers have determined that instructions carried out with virtual laboratories significantly increase student achievement levels (Dalgarno, Bishop, Adlong, & Bedgood, 2009; Yu, Brown, & Billet, 2005 & Tatli, & Ayas, 2013). Virtual environments let students observe the process in more detail, compared to board and chalk activities of the traditional classroom or partially completed experiments of the real laboratory environment. In addition, virtual environments foster attention and motivation towards the course by supporting a discussion platform among partners, peers, and among students and teacher (Dobson, 2009; Lawrence, 2011).

Furthermore, some researchers even argue that performing experiments within a virtual environment is more effective than performing experiments in real laboratories (Gambari, Fagbemi, Falode & Idris, 2014; Pyatt & Sims, 2012; Swan & O'Donnell, 2009; Tatli & Ayas, 2012; Bayrak, Kanlı & Kandilİngeç, 2007). Studies showed that, in traditional learning environments, there are always inconsistencies between student predictions and observations (Kerr, Rynearson, & Kerr, 2004; Josephsen & Kristensen, 2006). Such environments also make students reserved and cause them to refrain from expressing their opinions directly (Sheppard, 2006). In contrast, virtual learning environments enable learners to repeat the events several times without hesitation, to zoom in and out, and to watch in slow motion being questioned in any way (Tuyuz, 2010). Virtual laboratory is applicable to individualized or collaborative learning environments.

Individualized Instructional Strategy (IIS) is a teaching strategy in which an individual student works alone based on his/her ability using a variety of instructional activities to improve his/her understanding of chemistry. This strategy requires each individual to present his/her solution to the chemistry problem without the cooperation or assistance of other classmates (Aluko & Olorundare, 2011). McAllister and Mitchell (2002) reported that students taught using computer for individualizing learning usually have poor interaction with their peer therefore, there is need for collaborative learning.

In the submission of Vasiliou and Economides (2007), collaborative learning is a student-centered, task-based, activity-based learning approach that provides several advantages to the student. It can assist the students to enhance the skills of communication, interpersonal social relationship, cooperation of sharing and caring, openness, flexibility, adaptability, knowledge retention, higher-order of critical thinking, creativity, management, practicality, responsibility, trustworthiness of dependability, involvement, engagement of participation, commitment of persistency, motivation, confidence and self-efficacy. Meanwhile, it is an educational method in which students work together in small groups towards a common goal (Dillenbourg, Baker, Blaye & O'Malley, 1996; Hafner & Ellis, 2004). The teacher acts as a coach, mentor or facilitator of the learning process. The successful achievement of the common goal is shared among all group members.

Students, through virtual laboratory platform, can work together on a task, exchange their views, experiences, opinions, discuss and negotiate strategies, actions and results (Vasiliou & Economides, 2007). These actions can provide students with opportunity to assist, explain, teach, understand, review and influence each other. By developing a learning community, it could also provide the opportunity to combine the special abilities of everyone to achieve a common goal in a collaborative means. The teacher acts as a coach, mentor or facilitator of the learning process. The successful achievement of the common goal is shared among all group members.

In a training workshop organized in the Center for Advancing Teaching and Learning in 2010 at the University of Wisconsin, five major collaborative learning techniques were identified: Think-Pair-Share (TPS), Reciprocal Teaching (RT), Think-Aloud Pair Problem Solving (TAPPS), Group Grid (GG) and Group Writing Assignments (GWA). Each of the identified collaborative group aforementioned has their dynamics and extent of collaboration mode (Cerbin, 2010). In this study Reciprocal Teaching method of collaborative instructional strategy was explored. Reciprocal Teaching is also called Reciprocal Peer Tutoring (RPT). Reciprocal Peer Tutoring collaborative strategy is a procedure in which small groups work together on learning tasks (Dufrene, Noell, Gilbertson & Duhon 2005). In this type of collaborative learning, students function reciprocally as both tutor and tutee (Ogbuanya, Bakare & Igweh, 2009; Obiunu, 2008). This dual role is beneficial because it enables students to gain from both the preparation and the instruction in which tutors engage and from the instructions that tutees receive (Obiunu, 2008, Oludipe, 2007). RPT helps teachers to cope with challenges such as limited instructional time, multiple curricular requirement and appropriate social engagement among learners (Ogbuanya et al, 2009).

The effectiveness of RPT in the teaching and learning process has largely been documented. Studies have shown that RPT increased students' academic achievement, engagement, and reduce time spent on learning (Egbockuku and Obiunu, 2006; Oludipe, 2007, Ogbuanya, Bakare & Igweh, 2009). Oludipe (2007) and Egbujuo (2012) reported significant improvement in achievement of students in physics and chemistry respectively after they were exposed to RPT. In another study by Ogbuanya et al (2009), there was a significant effect on students' achievement in electronics technology after the students were also exposed to Reciprocal Peer Tutoring. Similarly, Slavin, (1993), Magolda and Rogers (1987) have shown that RPT is an effective technique for increasing students' academic achievement irrespective of their ability levels.

Students' ability level is one of the factors that responsible for differential learning outcome and it has attracted the attention of educational researchers. In Nigeria classroom, it is common to find students of mixed academic ability levels lumped together without considering their individual differences (Gambari, James & Olumorin, 2013). The capacity of students to engage themselves in any educational task which requires higher cognitive functioning depends on factors which include their academic potentiality. This could be tagged ability or level of academic attainment. Students are not the same especially when we find out the rate at which facts and principles in sciences are being assimilated. This is to say that, there is disparity in the ability to perform specific tasks (Adesoji, 2008). Several studies have shown that learners are qualitatively different in their ability levels and in learning problems. For instance, Aluko (2004), Fajola (2000), Ige (2004), Gambari, Olumorin and Yusuf (2013), Gambari and Yusuf (2014) found that high ability learners are more intelligent than the low or medium ability learners in solving task in science courses.

Yusuf (2004) identified three ability levels in relation to teaching-learning situation viz: High, medium and low. High ability level learners are those that prefer isolation and social distance, theoretical and abstract ideas (akin to field independent learners). According to him, high ability individuals are better than medium or low ability group might be better in other tasks that have to do with the use of hands. In this case, the high ability group has greater ability to structure information and solve problems. However, medium ability level learners perform relatively better on learning activities involving social materials, and are more likely to require external defined goals and reinforcements (Yusuf, 1997; Abakpa & Iji, 2011). Based on this classification, students can be grouped based on their ability levels. Many of the previous studies did not consider the effects of ability grouping on gender.

Gender differences have historically been held responsible for divergence in academia and career success. Many argue that females are more likely to have better verbal abilities than males and conversely, males are more likely to have better mathematical skills than females (Skaalvik & Skaalvik, 2004). Researchers contend that soon after children enter elementary school, females begin to fall behind males on standardized assessment (Leahey & Guo, 2001). Freeman (2004), Meece, Glienke, and Burg (2006) and Weinburgh, (2000) reported that female students enrolled in more advanced high school science courses than males. Males always outperform females in elementary, middle and high school in science achievement (Gender Differences in Science, 2009; National Center for Education Statistics, 2009). In 2007, scores from the American College Test (ACT) indicated that females were less prepared for college science courses (Gender Differences in Science, 2009). The West African Examination Council results in Chemistry for the last five years indicate that good performance was by male students (WAEC, 2015). A study done by Sempala (2005) in USA, showed that gender inequities were most evident in laboratory assignment, consistent with Tobin's (1990) observation that females are less likely to be involved in operating laboratory equipment. This discrepancy between male and female science achievements continues in postsecondary education where women are less likely to major in science disciplines (Britner, 2008; Freeman, 2004; Gender Differences in Science, 2009; Miyake Kost-Smith, Finkelstein, Pollock, Cohen, & Ito, 2010). Previous achievement, gender stereotypes and interest in the discipline may all affect how females approach studying science as well as motivation to pursue degrees or careers in the field.

The urgent need for Nigeria to shift steadily and progressively from the traditional time tested methods and techniques of instructions as expository, teacher-centred demonstration, and laboratory exercises to demonstrate, visualize or verify known information to those based on Information Communication Technology (ICT) requires a fundamental shift of focus from the teacher to the learner as the centre of education, and a progressive adoption of new method of virtual laboratory. Unfortunately, Nigeria is yet to embrace the concept fully and adopt ICT based methods in teaching, especially at the primary and secondary school levels. Hence, there is paucity of study reports on the effects of virtual laboratory on the achievement of secondary school students' in practical chemistry in individualized and collaborative setting in Minna, Nigeria.

In Nigeria, the Chemistry curricula is structured such that significant amount of time is set aside for practical demonstration. West African Examination Council (WAEC) Chief Examiners Reports 2012 and 2013 revealed among other things that candidates' performance was not encouraging. According to the reports students were unable to make logical inferences from experimental results and attributed the poor performance especially in practical aspect of Chemistry to their non-familiarity with the use of simple laboratory equipment.

Students need practical experiences to enable them understand some abstracts concepts in chemistry, therefore, effective use of laboratory equipment and facilities can improve the mastery of chemistry concepts. However, most of the public secondary schools in Nigeria are faced with insufficient laboratory and equipment which limits the teachers to perform just simple laboratory activity (Adejoh & Ityokyaa, 2009). Physical experiments are rarely performed in some public secondary schools in Nigeria due to lack of equipment, facilities and other logistic problems (Akinleye, 1987; Gambari, et al 2012). In addition, the costs of carrying out experiments, arranging the equipment for laboratory activities are very laborious and time consuming. Checking students' performance during the laboratory activities can be tasking especially when dealing with large class (Tuyuz, 2010). When taking all these challenges into consideration, looking for appropriate alternatives is necessary, hence, the use of virtual laboratory in supporting the traditional laboratory method or its adoption in the absence of physical laboratory is inevitable.

Research reports have shown that computer technology has been associated with improvement of performance in education (Hart, 2006; Asan, 2003). Virtual learning is one of such new techniques, Literatures on the use of virtual laboratories demonstration in science courses are scarce in Nigeria however, few research literatures reported that students exposed to virtual laboratory perform better than the traditional laboratory demonstration (Gambari, Falode, Fagbemi & Idris, 2013; Lawrence, 2011; Dobson, 2009; Swan & O'Donnell, 2009). However, Stuckey-Mickell and Stuckey-Danner (2007) reported that students considered the face-to-face laboratory courses to be more effective than virtual laboratory simulation. Kerr, Rynearson, and Kerr (2004) compared achievement among students instructed using hands-on Chemistry labs versus those instructed using virtual Chemistry laboratory (eLabs). They found out that there were no significant differences in achievement gain scores for the traditional versus the Virtual simulation. On the other hand, Svec and Anderson (1995) reported that computer simulation experiments are more effective than physical laboratory demonstration. Literatures on the findings of practical simulation of laboratory experiment have not been consistent.

From the literatures reviewed so far much has not been done on the use of virtual laboratory in Chemistry especially at senior secondary school level in Nigeria. Also, comparative studies on the effects of virtual laboratory in individualized and collaborative settings are very scanty. Furthermore, findings on the influence of gender and ability levels on students' achievements have not being conclusive. Therefore, there is need to carry out a study on the effects of virtual laboratory in individualized and collaborative setting considering other related variables.

Research Hypotheses

The following hypotheses are formulated and tested at 0.05 level of significance:

(i) There is no significant difference in the mean achievement scores of chemistry students taught using virtual laboratory in individualized and collaborative settings.

(ii) There is no significant difference in the mean achievement scores of male and female chemistry students taught using virtual laboratory in individualized Setting.

(iii) There is no significant difference in the mean achievement scores of male and female chemistry students taught using virtual laboratory in collaborative setting.

(iv) There is no significant difference in the mean achievement scores of high, medium and low chemistry students taught using virtual laboratory in individualized setting.

(v) There is no significant difference in the mean achievement scores of high, medium and low ability chemistry students taught using virtual laboratory in collaborative setting.

METHODOLOGY

Research Design

The research design adopted for this study is a quasi-experimental which involves the pretest, posttest experimental and control group design. This design was adopted because the two groups involved have a common variable (achievement and gender). Tuckman (1978) and Karlinger (1974) advocated the use of this design in a situation where two or more groups possess the same variables. In this study, two levels of independent primary variable (two treatments), three levels of academic ability (high, medium and low) and two levels of gender (male and female). Both the experimental and control groups were given the pretest and posttest. Experimental Group was subjected to treatment using virtual laboratory package in collaborative setting while the Control Group was also subjected to virtual laboratory package in individualized setting. The design layout is as shown in the Table 1.

Table 1: Research Design Layout

Groups	*Pre-test*	*Treatment*	*Post-test*
Experimental Group	O_1	Collaborative virtual laboratory	O_2
Control Group	O_3	Individualized Virtual Laboratory	O_4

The independent variables in this study are the virtual laboratory in collaborative and individualized settings while the dependent variable is the achievement scores. Gender and ability levels are the moderating variables.

Sample and Sampling Techniques

The population of this study is the entire senior secondary school chemistry students in public schools within Minna Nigeria. Based on the nature of this research, a three-stage sampling technique was employed. First, a purposive sampling technique was employed to obtain two secondary schools in Minna, Nigeria. These schools were purposively sampled based on certain criteria: equivalence (chemistry laboratories, facilities and teachers), school type (public schools), gender composition (mixed schools), ICT equipment (computer laboratories under the School Net programme) and exposure (students and teachers' exposure to the use of computer in their schools).

Secondly, the selected two equivalent mixed schools were randomly assigned to the experimental and control group using simple random sampling technique. Finally, stratified sampling technique was used to select sample size for this study. The arranged list of element in the school into different strata based on gender (male & female) and ability level (high, medium & low), then, the required number was selected from each stratum. In order to achieve a higher degree of precision, the researcher based the selection on proportions. For instance, the number selected from each stratum was on the basis of the proportion of the students in all the strata. After this, the researcher applied the simple random technique to select the people from the list in each stratum.

Students were grouped into ability levels (high, medium and low) based on their performance in the last promotion examinations in chemistry. The high level students were those whose average score fall within upper quartile (25%) which is (75-100%), medium level students were those whose mean score fall within medium quartile of 50% which is (50 - 74%) while low achievers are students whose mean score in the chemistry test fall within the bottom quartile of 25% which is (0-25%).

Two co-educational schools were selected for this study. A school was assigned to control group, while the other was assigned to collaborative learning group. Sixty students were assigned to virtual laboratory individualized learning strategy group. The experimental group (virtual laboratory collaborative learning) was assigned to gender and ability levels. Similarly, three students of the same ability level formed a group (i.e. high or medium or low only).

Grouping was achieved as follows: Ten students who scored highest in the last chemistry examination in the SSII were selected (they were stratified along gender) as high achieving students, and among the ten who scored lowest were selected as low achieving students. Ten among those who scored above average were selected as average achievers. In each collaborative learning class, for instance, there are three high-achieving, three average-achieving, and three low-achieving teams. The selection considered equal number of male and female students based on ability levels. These groups remained in place until the end of the treatment. The teams were formed immediately after the pretest. All students were exposed to the same treatment for the period of four weeks.

Table 2: Distribution of Sample for the Study

Groups	Gender		Achievement Levels		
	Male	Female	High	Medium	Low
Individualized	30	30	20	20	20
Homogeneous	15	15	10	10	10
Heterogeneous	15	15	10	10	10

From Table 2, the three groups comprised a total of 120 students, 30 students were exposed to reciprocal Peer Tutoring collaborative learning in collaborating settings (Experimental Group), another 30 students were exposed to Peer Tutoring collaborative learning setting, while 60 students were exposed to individualized virtual laboratory setting which was the control group.

Validation of Research Instrument
(i) Treatment: The validation of the research instrument (virtual laboratory package) took place in two phases: (a) experts validation by computer laboratory programmers and educational technology experts; (b) content validation by chemistry teachers.

Experts' Validation: The developed virtual laboratory package was given to two computer programmers to determine the appropriateness of the package in terms of language, typography, legibility, navigation, interface, animations, functionality, packaging, and durability. Similarly, two Educational Technology experts were requested to validate the package in terms of its suitability for instruction, simplicity, unity among illustrations, emphasis on key concepts, colour use, and text. Their suggestions and recommendations were used to modify the package.

Content Validation: Two secondary school teachers who are qualified and are currently teaching chemistry were requested to validate the experiments and the procedures for their learning which is contained in the treatment. They helped to ensure that all the contents and learning items are derived from the subject's curriculum and suitable for SSII chemistry students.

(ii) Chemistry Achievement Test Validation: CAT was given to two senior lecturers in Chemistry Department, Federal University of Technology, Minna, two chemistry teachers from secondary schools and two measurement and evaluation experts. These experts assess the face and content validity of the instrument in relation to the background of chemistry for secondary school students in SS two. Also, they examined all the items in the test instrument with reference to the: appropriateness of the content, and the extent to which the contents cover the topics they are meant to cover.

Reliability of the Instrument
To test the reliability of Chemistry Achievement Test (CAT), it was pilot tested in one selected senior secondary schools in Minna, Nigeria. The samples from these schools were part of the research population, but were not selected for the real studies. The test instrument (CAT) was administered once on 25 selected students. The results obtained from this administration were subjected to Kuder Richardson's formula 20 (KR-20). The results showed that CAT had a reliability coefficient of 0.91. On the basis of the high index, the instrument was considered reliable and suitable in conducting the research.

Method of Data Collection
The researcher along with trained research assistants examined the facilities in the selected schools. They also examined the facilities to determine their suitability for the study and seek for official permission and cooperation of the school management to use the schools. The cooperation of the students and staff in the selected schools were sought; they were adequately informed about the objectives of the study. Chemistry teachers in these schools were trained as research assistants. The entire study covered a period of four (4) weeks.

During the first week, a pretest was administered to the control and experimental groups using Chemistry Achievement Test. In the second week, the lesson was taught to the experimental group using virtual chemistry lab package in collaborative setting, while the control group was taught using virtual chemistry lab package in individualized setting after which the questions that were used for the pretest was reshuffled and administered to the students in the various groups as posttest. The actual teaching last for four weeks. The control and experimental group had two periods of 40 minutes each in a week with each class. The two secondary schools constitute one experimental group and a control group. The experimental group was exposed to the use of virtual chemistry lab in a collaborative setting while the control group was exposed to the use of virtual chemistry lab in an individualized setting.

Experimental Procedures
Control Group: Individualized Virtual Laboratory Instruction (IVLI) method was used here. The students were taught the concepts by using virtual laboratory package only. Students proceeded with the chemistry practical and study at their own rate. Sets of questions were given to the students after each sequence of instruction and students provided answers to the questions without any teacher's or peer's interactions. The teacher's role was to monitor the activities of the students so as to ensure strict compliance with instructions of non-interaction among members.

Experimental Group: The learning activity involves students teaching one another in a group of three-member. Students jointly read a text or work on a task. Students take turns being the teacher for a segment of the text or task. In their teaching role, students lead the discussion, summarize material, ask questions, and clarify material. In this study, Virtual Laboratory package was used with Reciprocal Peer Tutoring strategy in a collaborative learning. Reciprocal Peer Tutoring involves the following four phases:
(i) Instructor prepares students by showing how to perform the experiment in the video section of Virtual Laboratory Package
(ii) In a group, students jointly study the course material presented via Virtual Laboratory
(iii) Students take turns being the teacher and leading discussion of a segment of the demonstration
(iv) Students summarized the segment, asks a question, and clarifies material

The forth week was used for posttest which was administered to the control and experimental groups. The test was distributed with the help of two teachers from each school. Thirty minutes was given to write the test. The scores from the test given to the experimental and control groups was recorded and subjected to data analysis.

RESULTS
The data obtained from each group using Chemistry Achievement Test (CAT) were analyzed using Analysis of Covariance (ANCOVA) statistics. Four hypotheses were tested using ANCOVA. One of the reasons of the choice of ANCOVA for testing the research hypotheses was based on its ability to control for the effect of pre-test. All hypotheses were tested at 0.05 level of significance. Descriptive statistics was also used to give a simpler interpretation of the data and was further supported by graphical illustration. The results are presented in the tables based on the hypotheses.

Hypothesis One: There is no significant difference in the mean achievement scores of chemistry students taught using virtual laboratory in individualized and collaborative settings.

Table 1a: ANCOVA of posttest scores of individualized and collaborative settings using pretest as covariate

Source of Variation	Sum of Square	df	Mean Square	F	Significance (P)
Covariate (Pretest)	44.071	1	44.071	0.905	0.343
Main Effect (Treatment)	15286.055	1	15286.055	314.014	0.000*
Model	15799.279	2	7899.640	162.278	0.000
Residual	5695.512	117	48.680		
Total	487125.000	120			

*Significant at 0.05 level.

Table 1a shows the ANCOVA comparison of posttest achievement scores of individualized and collaborative settings. An examination of Table 4.1a shows that F (1,120) = 314.014, p = 0.000, the results of the analysis indicates that the main effect (treatment) was significant. On the basis of this, the hypothesis one was rejected. The results revealed that the strategies of instruction produced a significant effect on the posttest achievement scores of students when covariate effect (pretest) was controlled. The result indicates that the treatment, using individualized and collaborative settings accounted for the difference in the posttest achievement scores of the students. This implies that a statistical significant difference exists between the two groups of individualized and collaborative settings. To further show the improvement in learning after treatment, the mean gain scores between the pretest and posttest mean achievement scores of the two groups (individualized and collaborative settings) as shown in Table 1b and Figure 1.

Table 1b: Mean gain scores of students taught chemistry using virtual laboratory in individualized and collaborative settings

Group	Pretest	Posttest	Mean Gain Score
Individualized Setting	20.66	50.83	30.17
Collaborative Setting	24.00	73.75	49.75

From Table 1b, it was observed that the two groups had improvement as observed in their posttest. For instance, collaborative setting had highest mean gain scores 49.75 while Individualized setting had mean gain scores of 30.17. This shows that both groups benefited from the treatment.

Hypothesis Two: There is no significant difference in the mean achievement scores of male and female chemistry students taught using virtual laboratory in individualized setting.

Table 2a: ANCOVA of achievements of male and female students taught chemistry virtual laboratory in individualized setting

Source of Variation	Sum of Square	df	Mean Square	F	Significance (P)
Covariate (Pretest)	7.407	1	7.407	0.247	0.621
Main Effect (Gender)	145.927	1	145.927	4.862	0.032*
Model	147.609	2	73.804	2.459	0.095
Residual	1710.725	57	30.013		
Total	156900.000	60			

*Significant at 0.05 level.

Table 2a shows the result of the hypothesis two. The hypothesis was tested using the pretest mean achievement scores of male and female as covariate for the analysis of Covariance. The F value of 4.862 was significant at 0.05 alpha level when $F(1, 60) = 4.862$, $p < 0.05$. The result shows that there was significant difference in the mean achievement scores of male and female students taught using virtual laboratory in individualized setting. On this basis, hypothesis two is therefore rejected. This shows that male students' achievement differed significantly from that of female students when both were taught with virtual laboratory. The mean gain scores between the pretest and posttest of male and female students using virtual laboratory in individualized setting was analyzed as shown in Table 2b.

Table 2b: Mean gain scores of male and female students taught chemistry using virtual laboratory in individualized setting

Group	Pretest	Posttest	Mean Gain Score
Male	21.37	52.41	31.04
Female	20.00	49.35	29.35

From Table 2b, male and female achievement was improved after posttest. For instance, Male students had highest mean gain scores of 31.04 while female students had mean gain scores of 29.35. This shows that both groups benefited from the treatment.

Hypothesis Three: There is no significant difference in the mean achievement scores of male and female chemistry students taught using virtual laboratory in collaborative setting.

Table 3a: ANCOVA of achievement of male and female students taught chemistry virtual laboratory in collaborative setting

Source of Variation	Sum of Square	df	Mean Square	F	Significance (P)
Covariate (Pretest)	52.173	1	52.173	0.777	0.382
Main Effect (Gender)	3.188	1	3.188	0.048	0.828^{ns}
Model	55. 923	2	27.961	0.417	0.661
Residual	3825.327	57	67.111		
Total	330225.000	60			

ns: Not Significance at 0.05

Table 3a reveals the result of the hypothesis three. The hypothesis was tested using the pretest mean achievement scores of male and female as covariate for the analysis of Covariance. The $F(1, 60) = 0.048$, was not significant when $p = 0.828$ ($p > 0.05$). This shows that there was no significant difference in the mean achievement scores of male and female students taught using virtual laboratory in collaborative setting. On this basis, hypothesis three is therefore not rejected. This implies that male students' achievement did not significantly differ from that of female students when both were taught with virtual laboratory. The mean gain scores between the pretest and posttest between male and female students using virtual laboratory in collaborative setting was analyzed as shown in Table 3b.

Table 3b: Mean gain scores of male and female students taught chemistry using virtual laboratory in collaborative setting

Group	Pretest	Posttest	Mean Gain Score
Male	24.17	75.50	51.33
Female	23.83	74.00	50.17

Table 3b shows that male and female students' achievement was improved after posttest. Male students had mean gain scores of 51.33 while female students had mean gain scores of 50.17. This shows that both groups benefited from the treatment.

Hypothesis Four: There is no significant difference in the mean achievement scores of high, medium and low chemistry students taught using virtual laboratory in individualized setting.
To find out whether any statistical significant difference exist in the posttest mean scores of high, medium and low level students taught with chemistry virtual laboratory using analysis of covariance (ANCOVA), is shown in Table 4a.

Table 4a: ANCOVA of mean achievement scores of high, medium and low level students taught chemistry virtual laboratory in individualized setting

Source of Variation	Sum of Square	df	Mean Square	F	Significance (P)
Covariate (Pretest)	34.123	1	34.123	1.113	0.296
Main Effect (Levels)	139.283	2	69.642	2.271	0.113^{ns}
Model	140.965	3	46.988	1.532	0.216
Residual	17.368	56	30.667		
Total	156900.000	60			

ns: Not Significance at 0.05

Table 4a presents the result of the analysis of covariance using the pretest scores of students in the three achievement levels as covariates. The result shows that F - value of 2.271 for the main effect was significant at 0.05 alpha level i.e. $F (2, 60) = 2.271$, $p > 0.05$. This implies that there is no statistical significant difference in the mean achievement scores of the high, medium and low level students. On this basis, hypothesis four was not rejected. Therefore, there is no significant difference in the performance of high, medium and low level students taught using chemistry virtual laboratory. To further show the improvement in learning after treatment, the mean gain scores between the pretest and posttest mean achievement scores of the three groups (low, medium and high) are shown in Table 4b.

Table 4b: Mean gain scores of high, medium and low students taught chemistry using virtual laboratory in individualized setting

Group	Pretest	Posttest	Mean Gain Score
High	13.68	50.53	36.85
Medium	20.27	52.78	32.51
Low	26.73	49.57	22.84

Table 4b reveals that all the three groups had improvement as after posttest. For instance, high level students had mean gain scores 36.85; followed by medium students with the mean gain scores of 32.51, while the low level students had the least mean gain scores of 22.84. This shows that all the groups benefited from the chemistry virtual laboratory using individualized setting.

Hypothesis Five: There is no significant difference in the mean achievement scores of high, medium and low ability chemistry students taught using virtual laboratory in collaborative setting.
To find out whether any statistical significant difference exist in the mean achievement scores of high, medium and low ability level students taught with chemistry virtual laboratory, the analysis of covariance (ANCOVA) was used.

Table 5a: ANCOVA of mean achievement scores of high, medium and low ability level students taught chemistry virtual laboratory in collaborative setting

Source of Variation	Sum of Square	df	Mean Square	F	Significance (P)
Covariate (Pretest)	22.645	1	22.645	0.339	0.563
Main Effect (Levels)	84.494	2	42.247	0.632	0.535^{ns}
Model	137.228	3	45.743	0.684	0.565
Residual	3744.022	56	66.858		
Total	330225.000	60			

ns: Not Significance at 0.05

Table 5a shows the result of the analysis of covariance using the pretest scores of students in the three achievement levels as covariates. The result shows that F- value of 0.632 for the main effect was not significant at 0.05 alpha level ($F (2, 60) = 0.632, p > 0.05$). This means that there is no statistical significant difference in the mean achievement scores of the high, medium and low level students. On this basis, hypothesis five was not rejected. Therefore, there is no significant difference in the mean achievement scores of high, medium and low level students taught using chemistry virtual laboratory. To further show the improvement in learning after the treatment, the mean gain scores between the pretest and posttest mean achievement scores of the three groups (high, medium and low) are as shown in Table 5b.

Table 5b: Mean gain scores of mean achievement scores of high, medium and low level students taught chemistry virtual laboratory in collaborative setting

Group	Pretest	Posttest	Mean Gain Score
High	12.00	75.00	63.00
Medium	23.33	75.00	51.67
Low	31.11	72.22	41.11

From Table 5b, it was observed that all the groups had improvement as observed in their posttest. For instance, high and medium students had highest mean gain scores 63.00 and 51.67 while low level students had mean gain scores of 41.11. This shows that the three groups benefited from the chemistry virtual laboratory using collaborative setting.

DISCUSSION

This study was conducted to determine the effects of Virtual laboratory instructional package to teach practical aspect of chemistry and find out its effectiveness in individualized and collaborative setting on senior secondary school SSII students in Minna, Niger State.

Hypothesis one showed that students exposed to chemistry virtual laboratory package in Reciprocal Peer Tutoring collaborative setting outperformed their counterparts in individualized settings. These findings agree with the earlier finding of Chandra and Watters (2012) and DeGennaro (2008) who reported that the performance of students in social media for collaborative learning was more effective than the performance of students in social media for individual learning. The study was also supported by Ezenwosu and Nworgu (2013) who reported that students taught biology using peer tutoring performed significantly higher in Biology Achievement Test than those taught biology using the conventional lecture method. It also agrees with the findings of Jibrin and Zayum (2012) who reported that students taught biology using peer tutoring instructional method achieved higher than those taught using expository method. In the same vein, it supported the findings of Agoro and Akinsola (2013) who reported that Pre-service Science Teachers exposed to Science Process skills using Reflective Reciprocal Teaching (RRT) group had higher mean score than those in the Reflective-Reciprocal Peer Teaching (RRPT) and the control groups. The study also agrees with a longitudinal study conducted by Ching and Chnag-Chenm (2010) who revealed that the reciprocal peer tutoring program was been successful in regard to tutors and tutees' achievements, motivation and attitudes of university students at National Formosa University in Taiwan during academic years 2007 to 2009. It also agreed with a study conducted by Waghmare, Sontakke, Tarnekar, Bokariya, Wankhede and Shende (nd) reported that overall 90%

students agreed that the Reciprocal Peer Tutoring (RPT) instructional strategy increased their understanding of the topics they taught in Anatomy. In addition, 92% students agreed that RPT improved their communication skills, which can be applied beyond anatomy to their careers as a future physician.

When examine the effects of virtual laboratory on students' achievement, the results of this study supported the findings of Hwang, Kongcharoen and Ghinea (2014) conducted a study extends previous research by designing the Networking Virtualization-Based Laboratory (NVBLab), which requires collaborative learning among the experimental students. The results show that the experimental group significantly outperformed the control group in two Advanced Labs and the post-test after Advanced Labs. Furthermore, the experimental group's activities were better than those of the control group based on the total average of the command count per laboratory. Finally, the findings of the interviews and questionnaires with the experimental group reveal that NVBLab was helpful during and after laboratory class. The finding also agrees with the finding of Tatli and Ayas (2013) who concluded that the developed virtual chemistry laboratory software and physics virtual laboratory package as effective as the real laboratory, both in terms of student achievement in the unit and students' ability to recognize laboratory equipment. Similar to this finding is the study conducted by Gambari, Falode, Fagbemi and Idris (2013) which showed that the application of the virtual laboratory had positive effects on students' achievements, retention and attitudes when compared to physical laboratory method. Also, the study agreed with finding of Flower (2011) who examined students' perceptions of biology using virtual laboratories. From the findings, students indicate their preference to participate in virtual labs compared to traditional (e.g., face-to-face) labs. The finding of this study is in the same direction with finding of Efe and Efe (2011) who revealed that students taught with the help of computer simulations made statistically significant improvements in their test scores on all six levels (knowledge, comprehension, application, analysis, synthesis and evaluation) of Bloom's taxonomy. Also, it in line with the findings of Tüysüz (2010) which showed that virtual laboratory applications made positive effects on students' achievements and attitudes when compared to traditional teaching methods after exposed to 'Separation of Matter'. Similarly, Pyatt and Sims (2007) reported that the simulated laboratory can serve as a legitimate alternative to the expository, "hands-on" laboratory. Similarly, it concurred with the studies of Mahmoud and Zoltan (2009), Abdulwahed and Nagy (2009), Abdullah and Shariff (2008) and Yaman, Nerdel and Bayrhuber (2008) reported that reported that virtual labs provides handy and cheap way for supporting laboratory education; enhanced students' performance; risen their conceptual understanding and has also contributed to reducing the students' cognitive load. On the same note, Murniza, Halimah and Azlina (2010) revealed that virtual laboratory for biology can support students to explore and visualize the abstract concepts in learning biology especially in "Describing the application of knowledge on mitosis in cloning".

However, the finding of this study contradicts with the findings of Azar and Şengüleç (2010) who found that students' achievements and attitudes towards physics using the computer-assisted teaching method can be more effective than the laboratory-assisted teaching method. Similarly, it did not support the finding of Başer and Durmuş (2010) reported no significant effect among the pre-service teachers exposed to Direct Current Electricity (DCE) in virtual (VLE) and real laboratory environment (RLE). Similarly, Kaewprapan and Suksakulchai (2008) found that students exposed to virtual reality module within one course and traditional lecture within another did not significantly differ in their performance after the treatment. It also disagrees with the finding of Gorghiu, Gorghiu, Alexandrescu and Borcea (2009) who reported that traditional laboratories were more effective, despite the fact that virtual laboratories provided a variety of benefits.

The hypotheses two reveals that there is significant difference in the mean performance scores of male and female students taught using virtual chemistry laboratory package in individualized settings. This confirmed the findings of Gambari, Falode, Fagbemi and Idris (2012) who reported that gender had no influence on the performance of students exposed to physics virtual laboratory during posttest and retention test. It also agrees with findings of Al-Mahmadi (2008) who revealed that the use of virtual laboratory in chemistry is gender-neutral while Plumm (2008) in his research findings revealed that there are significant gender-related differences in performance and interaction style in computerized learning environments.

Hypothesis three showed that there was no significant difference in the mean achievement scores of male and female students taught chemistry using virtual laboratory in collaborative setting. The finding of this study agrees with findings of Annetta et al. (2009), Ajaja & Eravwoke (2010), Gambari, 2010, Kost et al. (2009), Yusuf and Afolabi (2010) and Gambari, Yusuf and Olumorin (2013) who reported that gender had no effect on academic performance of students in cooperative learning. It also agrees with study of Yusuf (2004) who found no significant difference in the performance of male and female students taught using both Cooperative Instruction Strategy and Competitive Instructional Strategy. This corroborate with the finding of Ige (2004) who examined the effect of cooperative learning strategy on senior secondary school chemistry students' performance in solving electrolysis problems in Ilora, Nigeria and found that gender did not have any significant influence on the performance of students. However, the findings of this study disagree with the finding of Ezenwosu and Nworgu (2013) who revealed that male students slightly performed better than female students when taught biology using peer tutoring. It also disagrees with the findings of Ali, Suliman, Kareem and Iqbal (2009) who conducted a comparative study on gender performance on an intelligence test among medical students and found that male students as a group, scored higher than the female students as a group, the difference was small but statistically significant ($p = 0.015$). Furthermore, it disagrees with the findings of Cavallo, Potter, and Rozman (2004) who reported that male students earned significantly higher in final course grades than female students when differences in learning approaches and motivational goals between male and female students enrolled in college physics where investigated. Contrary to those studies in favour of male students, Britner (2008) reported that females earned higher grades in Life science, but scored lower in self-efficacy and more anxiety. In physical science, there were no gender differences in grades or self-efficacy, but females reported more anxiety. Self-efficacy scores predicted science grades for males and females. Similar to Britner (2008) findings DeBacker and Nelson (2001) also reported that female students scored higher on measures of future value and teacher pleasing goals than male students. Both reports disagree with the findings of this study.

Hypotheses four showed that there was no significant difference in the mean achievement scores of high, medium and low students taught using chemistry virtual laboratory in individualized setting. This finding agrees with the findings of Anyanwu, Ezenwa, and Gambari (2013) who found no significant difference in the posttest mean scores of high, medium and low achiever students taught using computer Animation with Text. It also agrees with Borge (2006) who found no significant differences among students of different ability grouping. However, it disagrees with the findings of Gambari, Balogun and Alfa (2014) who revealed that high achievers performed better than medium and low achievers respectfully when taught Isometric and Orthographic Projection with Interactive Whiteboard.

Hypotheses five revealed that there was no significant difference in the mean achievement scores of high, medium and low level students taught chemistry virtual laboratory in collaborative setting. This agrees with the findings of Yusuf (2004) who revealed that scoring ability levels of students did not influence their performance when taught Social Studies using Cooperative Instruction Strategy. However, this finding disagree with the finding of Aluko (2004), Aiyedun (1995), Balfakih (2003), Fajola (2000), Gambari, Yusuf and Olumorin (2013) and Ige (2004) who reported significant difference between students of high, medium and low ability level in favour of high and medium respectively. Similarly, the finding agrees with the finding of Gambari (2010) who revealed that students' academic achievement levels had significant difference on their performance in Jigsaw II, STAD and TAI cooperative learning strategy. These significant differences existed among the students in Jigsaw II, STAD, and TAI cooperative learning strategies in favour of high achievers, then medium achievers and low achievers. This finding was supported by Adeyemo (2010) findings after conducting a study on students' ability level and their competence in problem-solving task in physics and found that students' ability had significant influence on problem-solving task. This finding was in line with Abakpa and Iji (2010) who asserted that with the traditional method of teaching, the gap between the achievement of high, medium and low ability students continue to widen.

CONCLUSION

The application of virtual lab package in collaborative setting in the learning of chemistry was found to be more effective because it enhanced students' performance. Achievement levels (high, medium & low) had no significant difference on students taught using virtual learning in collaborative and individualized settings. Male and female students were affected positively by the use of reciprocal peer tutoring collaborative learning than individualized learning. This implies that collaborative setting is gender friendly.

Recommendations

In the light findings drawn from the study, the following recommendations are made:

(i) The use of virtual laboratory in collaborative setting proved to have positive effect on the achievement of students, therefore teachers should be encouraged to use virtual laboratory package in collaborative setting.

(ii) Collaboration among students should be encouraged to improve sharing of knowledge and skills among themselves.

(iii) Gender disparity in chemistry students' achievement could be overcome by adopting virtual laboratory in collaborative learning environment.

(iv) Emphasizes should be accorded to Reciprocal Peer Tutoring in order to bridge the gaps between high, medium and low achievers' students.

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