The study examined the effects of laboratory equipment on performance and attitude change to biology learning among Senior Secondary School Students in Federal Capital Territory (FCT) Abuja. The study adopted a quasi-experimental pre-test and posttest matched group design. The sample consisted of 136 Senior Secondary School class II (SSSII) biology students. They were drawn from two (2) co-educational Secondary Schools using criterion sampling techniques. Four null hypotheses were tested at 0.05 alpha levels. Three instruments were used. They include: Biology Laboratory Equipment Check List (BLCL), Biology Practical’s Achievement Test (BIOPAT) and Biology Students’ Attitude Change Questionnaire (BSACQ). The reliability indices of BIOPAT and BSACQ were determined using split-half methods and 0.78 and 0.82 indices respectively were established and considered adequate for the study. The reliability index of BLCL was determined using split-half method and a reliability index of 0.75 were established, which was considered adequate for the study. The findings indicated a significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory. The difference was in favour of those exposed to adequately equipped laboratory. Also, that, the attitude change of biology students exposed to adequately equipped laboratory is not gender-related. It is therefore recommended that school authorities and stakeholders should ensure that Science laboratories are adequately equipped in Senior Secondary Schools so that they could remain centres of excellence where future scientists, engineers etc are prepared for University education in order to meet the goals of MDGS, EFA and vision 20-2020.

Key words: Secondary Education; Quality Assurance; School Variables; Student Learning

INTRODUCTION

Background

The emphasis on teaching and learning of science is on ensuring that teachers not only teach the process of science but also are able to subject scientific concepts to the sensory experience of the learners. By this, the ‘hands’ and ‘minds’ of learners must be on scientific activities such that learners will be able to learn actively and thereby participate in knowledge construction (Ausubel, 1963). In essence, the focus is on activity based science lesson which entails both best classroom and laboratory practices. This direction of teaching and learning of science subjects in schools is viewed to lead students to acquiring the required science process skills, life skills and competence as enshrined in the revised edition of (National Policy on Education (NPE) (FRN, 2013) National core curricular for Biology, Chemistry, Mathematics and Physics etc. However, the efforts of teaching in achieving the goals of NPE 2013, the Millennium Development Goals (MDGS), EFA, Science Education for all, NEEDS, Vision 20:2020 faces great challenges. The challenges facing science teaching and
learning includes the use of teacher-centred approaches to teaching, lack of adequate and relevant instructional materials, inadequate classroom and laboratories and laboratory equipment etc.

Laboratory is at the centre of scientific studies and/or sciencing so long as science remains both a product and process. The availability of laboratory equipment, facilities and materials play a vital role in determining the extent of best laboratory practices that will ensure acquisition of science process skills and competence in science concepts by the learners. According to Abimbola (2001) one major aspect of Science education that is of great concern is in the area of availability and effectiveness of use of specialized and relevant science equipment, facilities and instructional materials. The school laboratories that are well designed, stocked and safe for teaching and learning of science ensure active practical exercises (Katcha, 2005).

Laboratory work is an indispensable part of science instruction, and no effective science education can exist without practical work (Udo, 2010). Laboratory practicals are dependent on the level of equipping of the laboratory with relevant instructional materials and the ability of the teacher to effectively and efficiently utilize them. The challenges often faced in doing practicals in inadequately equipped laboratories has led teachers to separate science lessons into practical and theory lessons or classes and or shifting practical work until the second term of the final year (Ekpo, 1999). According to Ekpo any effort to separate Science into practical and theory lesson account to perpetuating the dichotomy and this is antithesis of what science is. The biology students have been performing below expectation because of poor laboratory practicals. The biology students are often many because it is thought to be simpler than other science subjects and instructional aids seemed to be very common as they can be sourced in the environment.

However, the students and teachers always found that the required materials are in short supply considering the number of students to utilize them and consequently students persistent poor performance in biology (WAEC, 2013). The current trend in science curricular emphasis implies that science laboratory work should be taught as an integral part of classroom instruction in science with pre-and-post laboratory discussion (Udo, 2010).

The research reports on the effect of gender on students’ achievement in Senior Secondary biology are conflicting. While some studies reported male superiority in science achievement (Ekeh, 2004, Ncharam, 2004) some others reported female superiority in science achievement (Shaibu and Man 1997; Galadima 2003). Also, other studies such as Ariyibi (2004) and Udo (2006) reported zero effect of gender in students’ achievement in Science. This group maintained that, if given the right conditions of teaching and learning both male and female would perform equally well in Science (Udo, 2010). According to Katcha (2005) the use of activity-based strategies of teaching such as Vee Maps showed that students’ achievement in biology is not sex dependent. The research on gender difference in school biology concepts is not conclusive and inadequate (Okeke, 2001; Odunusi, 2001; Katcha, 2005).

Students’ performance influences the attitude direction towards science. There is a significant relationship between learners’ performance in science and attitude towards science (Odunusi, 1984). Thus, positive attitude is related to achievement in biology while negative attitude is related to under achievement in biology. Although students have negative attitude to biology concepts, they possess positive attitude to activity-based science lessons (Okebakola, 1984).

Studies have indicated that girls have negative attitude towards science lessons while boys have more positive attitude to biology than girls. Schibeci (1984) reported that girls show a more positive attitude towards biology and boys towards chemistry and physics. Schibeci’s findings is corroborated by Weinbarg and Engechard's (1991) findings, that, girls have more positive attitude towards biology laboratory experiments and concepts than boys. According to Odunusi (1984) there is no gender difference with regards to attitude towards biology concepts and teaching. Thus, the research reports on students’ performance and attitude direction are conflicting, inadequate and not conclusive. Students’ attitude can change in three ways, by changing beliefs, (cognitive), feelings (affective) and behaviour (psychomotor). The change can be done by informational and cognitive consistency approaches particularly in this era of information and communication technology.

Statement of the problem

The dwindling students’ performance in science especially biology has been a source of concern to all stakeholders - the parents, teachers, students, science education researchers, government and the general public. Despite the efforts by science educators the performance of many students in science is still at abysmal level. In essence there are still gaps in the efforts and results available. This situation is easily attributed to factors of laboratory equipment supplied, gender factors and attitudes of students to science teaching and learning among others. With laboratory equipment, the modern trend emphasizes laboratory practicals as an integral part of classroom instruction in science with pre-and-post laboratory discussion if students have to learn Science as a process and product, and achieve to expectations of all the stakeholders and meet the demands of the vision 20:2020, NEEDS, EFA, and MDGS etc. As a result of conflicting research reports and its inadequacy, there is need to provide data on gender related differences in students’ achievement in Biology concepts.
Also that achievement in biology is related to attitude dimension and there is inconclusive and inadequate research reports on students’ attitude change and performance in biology concepts.

Consequently, this study is centred on providing data on laboratory equipment, students’ performance and attitude change to biology in Senior Secondary School in Federal Capital Territory (FCT).

**Research questions**

The answers to the following research questions were pursued:

I. Is there any significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory?

II. Is there any significant difference between the performance of male and female biology students exposed to adequately equipped laboratory?

III. Is there any significant attitude change to biology between students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory?

IV. Is there any significant difference between male and female biology students attitude change to biology when exposed to adequately equipped laboratory?

**Null hypotheses**

The following null hypotheses were tested at 0.05 alpha levels:

H01: There is no significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory.

H02: There is no significant difference between the performance of male and female biology students exposed to adequately equipped laboratory.

H03: There is no significant difference in attitude change to biology between students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory.

H04: There is no significant difference between male and female biology students attitude change to biology when exposed to adequately equipped laboratory.

**METHODOLOGY**

The study was quasi-experimental using randomised pre-test and posttest matched group design. The population for the study comprised all Senior Secondary School students (SSS) in FCT, given as 46,496 (Secondary Education Board (SEB, 2006). The SSS offered Biology as a compulsory science subject. The sample size consisted of 136 SSSII Biology students drawn from 2 co-education schools using criterion sampling technique. This is to ensure that the schools used for the study have separate laboratories for Biology, Chemistry and Physics subjects. Also, that the Biology laboratories of the 2 schools were investigated and ascertained that one is adequately equipped and the other is inadequately equipped.

There were three instruments for the study. These are Biology Laboratory Equipment Check List (BLCL), Biology Practical Achievement Test (BIOPAT) and Biology Students’ Attitude Change Questionnaire (BSACQ). The BLCL was designed as a 15-item multiple choice test for biology teachers in F.C.T secondary schools. The BLCL was used to classify biology laboratories available into adequately equipped and inadequately equipped. The BIOPAT was constructed as a 30-item, four options multiple choice biology practical tests. The BOSACQ was a 30-item, four point likert-scale attitude change questionnaire.

The three instruments and their marking schemes and lesson notes were validated by a team of 5 experts from Faculty of Education, University of Abuja and 5 experienced biology teachers from Federal University of Technology, Minna. The BIOPAT and BSACQ were pilot-tested on 50 students from schools within the study population but were not part of the final study. The reliability indices of BIOPAT and BSACQ were determined using split-half methods and 0.78 and 0.82 indices respectively were established and considered adequate for study. Also BLCL was validated by the same expert and pilot-tested on 10 biology teachers within the study population but did not form part of the main study. The reliability index of BLCL was determined using split-half method and a reliability index of 0. 75 were established, which was considered adequate for the study.

**Administration of the instruments**

The three instruments were administered concurrently and the study carried out in 3 phases.

**Phase 1 (2 weeks)**

In the first week permission was sought and granted by the school authorities in order to use their schools for the study. Thereafter, biology teachers from 10 SS schools served with BLCL and 5 SS schools were identified with adequately equipped biology laboratories. The results were then used to sample one school with the adequately equipped laboratory and another one with inadequately equipped biology laboratory.
Phase 2 (5 weeks)

This period covered the treatment proper which lasted for 5 weeks. The biology teachers of the intact classes engaged their students in biology practicals in the laboratory. The same topics were taught in both schools with adequately equipped biology laboratory and inadequately equipped biology laboratory. Thus, students were taught by their teachers in their intact biology laboratory during the normal biology practical period on the school timetable.

Phase 3 (1 week)

The posttest was administered to students at the end of 8th week of the study. The students of the 2 groups adequately equipped and inadequately equipped laboratory took the posttest.

DATA ANALYSIS AND RESULTS

The data generated were used to test the four (4) null hypotheses. The null hypotheses were tested using t.test statistics. The rejection or confirmation of the hypotheses was at p ≤ 0.05 level of significance.

Hypothesis one (H0₁)

There is no significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory.

The result in Table 1 showed the mean scores of 47.90 by biology students exposed to adequately equipped laboratory which is significantly higher than 38.50 made by those biology students exposed to inadequately equipped laboratory. The table also shows t. calculated value of 4.40 at p.value of 0.001 indicating a significant difference between the 2 groups. Thus, H0₁ is rejected, implying that there is a significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory in favour of those exposed to adequate equipped laboratory.

Hypothesis two (H0₂)

There is no significant difference between the performance of male and female biology students exposed to adequately equipped laboratory.

Table 2 shows that the t - calculated value of 1.09 at df 50 P value of 0.115 is retained at p >0.05 level of significance. So, H0₂ is therefore retained indicating that both male and female students performed favourably when exposed to adequately equipped laboratory.

Hypothesis three (H0₃)

There is no significant difference in attitude change to biology between students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory.

From the results shown in Table 3 there is a significant difference in attitude change to biology between students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory. The students exposed to adequately equipped laboratory showed a change of attitude that was more positive than the students exposed to inadequately equipped laboratory as shown in the attitude change sub-scales.

So, H0₃ is therefore rejected. The biology students exposed to adequately equipped laboratory have significantly more positive attitude change to biology as compared to biology students exposed to inadequately equipped laboratory.

Hypothesis four (H0₄)

There is no significant different between male and female students’ attitude change to biology when exposed to adequately equipped laboratory.

From the results shown in Table 4 there is no significant difference in attitude change to biology between male and female students exposed to adequately equipped laboratory. This means male and female students exposed to adequately equipped laboratory have the same type of attitude change that was more positive as shown in the attitude change sub-scales.

So, H0₄ is therefore retained indicating that male and female students exposed to adequately equipped laboratory have the same type of attitude change that was more positive as shown in the attitude change sub-scales.

i. Understanding laboratory equipment (with U.cal at 6322.5 and P.value of .0008 which is rejected at p < 0.05 level of significance)

ii. Enjoyment of laboratory exercises (U.cal of 6351.3 with p. Value of 0011 rejected at P < 0.05 level of significance)

iii. Biology Practical Skills (U.cal 5454.2 and p. value of 0062 rejected p < level of significance).

iv. Interest in Manipulation of laboratory equipment (U.cal 6341.1 and p. value of 0.001 rejected at p < 0.05 level of significance).
Table 1. The t-test Analysis of Biology Students’ Exposure to Laboratory Equipment.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>SD</th>
<th>SE</th>
<th>Df</th>
<th>t.cal</th>
<th>P.value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequately equipped lab</td>
<td>62</td>
<td>47.90</td>
<td>10.63</td>
<td>1.45</td>
<td>97</td>
<td>4.40</td>
<td>0.001</td>
</tr>
<tr>
<td>Inadequately equipped lab</td>
<td>74</td>
<td>38.50</td>
<td>9.10</td>
<td>1.30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05

Table 2. The t-test Analysis of Male and Female Biology Students Exposure to Laboratory Equipment.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>SD</th>
<th>SE</th>
<th>Df</th>
<th>t.cal</th>
<th>P.value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>38</td>
<td>45.05</td>
<td>12.00</td>
<td>2.30</td>
<td>50</td>
<td>1.09</td>
<td>0.115</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>43.47</td>
<td>10.24</td>
<td>1.94</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05

Table 3. Mann-Whitney (U) Test Analysis of Attitude Change to Biology on Exposure to Laboratory Equipment.

<table>
<thead>
<tr>
<th>Attitude Sub-scale</th>
<th>Questionnaire Items</th>
<th>Group</th>
<th>N</th>
<th>U.cal</th>
<th>P.value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding laboratory equipment</td>
<td>1,3,13,17,19,27</td>
<td>Adequately Equipped</td>
<td>62</td>
<td>6322.5</td>
<td>.0008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inadequately Equipped</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*signt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoyment of laboratory practicals</td>
<td>5,6,8,10,30,22,23,28,29</td>
<td>Adequately Equipped</td>
<td>62</td>
<td>6351.3</td>
<td>.0011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inadequately Equipped</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*signt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology practicals skills</td>
<td>2,4,12,15,18,20</td>
<td>Adequately Equipped</td>
<td>62</td>
<td>5454.21</td>
<td>.0062</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inadequately Equipped</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*signt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest in manipulation of laboratory equipment</td>
<td>7,9,11,14,16,21,24,25,26</td>
<td>Adequately Equipped</td>
<td>62</td>
<td>6341.1</td>
<td>.0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inadequately Equipped</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*signt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

U = Mann-Whitney value; *signt = significant

iii. Biology Practical skills (U.cal 238.3 and p value of 0.53 is retained at p > 0.05 level of significance).

iv. Interest in Manipulation of laboratory equipment (U.cal 107.5 and p value of 0.42 is retained at p > 0.05 level of significance).

The result shown in Table 4 indicates that the attitude change of biology students exposed to adequately equipped laboratory is not gender related. The male biology students did not show a significant attitude change to biology than the female students. This is shown in the attitude change sub-scales.

Summary of Findings

1. There is significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory.
2. There is no significant difference between the performance of male and female biology students exposed to adequately equipped laboratory.
3. There is significant difference in attitude change to biology between students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory.
4. There is no significant different between male and female students’ attitude change to biology when exposed to adequately equipped laboratory.

DISCUSSION OF FINDINGS

The results showed that there is a significant difference between the performance of biology students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory in favour of those exposed to adequately equipped laboratory. This finding is in agreement with earlier findings by Pwal (2000), Rebecca (2010) and Udo (2011). According to Pwal laboratory equipment enhances learners’ scientific
Table 4. Mann-Whitney (U) Test Analysis of Attitude Change of Male and Female Biology Students Adequately Exposed to Laboratory Equipment.

<table>
<thead>
<tr>
<th>Attitude Sub-scale</th>
<th>Questionnaire Items</th>
<th>Group</th>
<th>N</th>
<th>Ucal</th>
<th>Pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding laboratory equipment</td>
<td>1, 3, 13, 17, 19, 27</td>
<td>Male</td>
<td>38</td>
<td>160.4</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>24</td>
<td></td>
<td>*ns.</td>
</tr>
<tr>
<td>Enjoyment of laboratory practicals</td>
<td>5, 6, 8, 10, 30, 22, 23, 28, 29</td>
<td>Male</td>
<td>38</td>
<td>329.0</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>24</td>
<td></td>
<td>*ns.</td>
</tr>
<tr>
<td>Biology practicals skills</td>
<td>2, 4, 12, 15, 18, 20</td>
<td>Male</td>
<td>38</td>
<td>238.3</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>24</td>
<td></td>
<td>*ns</td>
</tr>
<tr>
<td>Interest in manipulation of laboratory equipment</td>
<td>7, 9, 11, 14, 16, 21, 24, 25, 26</td>
<td>Male</td>
<td>38</td>
<td>107.5</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>24</td>
<td></td>
<td>*ns</td>
</tr>
</tbody>
</table>

U = Mann–Whitney value, *ns = Not significant

understanding and interaction, with events and objects of performance of scientific interest' which in turn influences the performance of learners. Exposing students to adequately equipped laboratory leads to activity-based lesson in which case individuals will be able to actively participate and interact, thereby engaging in knowledge construct0.0. Acquisition of science process skills and scientific attitudes. At the end of the practical's Scientist at mind and hands are produced because they would have learnt actively and then interest and performance improved.

The male and female students performed equally well when exposed to adequately equipped laboratory. This finding is in consonance with Katcha Udo and Ariyibi who found out that if right conditions are provided either in the class or laboratory both male and female students would perform equally well in science. Although research studies on gender difference in students performance in biology is not conclusive but most research findings explained that students' achievement in biology is no sex dependent if adequate instructional materials and activity-based strategies are employed (KatchaUdo). The present findings disagree with Galadima (2003) and Ekeh (2004) who reported male superiority in achievement in Science. Also it disagrees with the findings by Shuaibu and Man (1997) who reported female superiority in achievement in science.

There is a significant difference in attitude change to biology between students exposed to adequately equipped laboratory and those exposed to inadequately equipped laboratory. The students exposed to adequately equipped laboratory showed a change of attitude that was more positive than those exposed to inadequately equipped laboratory as shown in the attitude sub-scales.

Thus, this finding is in agreement with earlier studies (Oloruko'oaba, 2002). They reported that students exposed to adequate provision of instructional materials under activity-based teaching strategies developed more positive attitude change to biology. They argued that students exposed to relevant and adequate instructional materials are opportune to participate and interact actively in the practical's, engage in knowledge construction and acquire skills, scientific at attitudes and competency. As such students exposed to adequately equipped laboratory would develop a higher positive attitude change to biology as compared to those students that are exposed to inadequately equipped Laboratory.

There is also no significant difference between male and female students' attitude change to biology when exposed to adequately equipped laboratory. This finding is in agreement with earlier studies by Katcha who reported that new teaching strategies and adequate provision of instructional materials lead to development of positive attitude change to biology which is not sex dependent. Laboratory equipment, materials and facilities when adequately supplied and are relevant are very facilitative in the cultivation of positive attitude and attitude change to science concepts and most especially biology concepts.

Implications for science education

The findings of this study have some implications for biology education. Laboratory equipment, materials and facilities constitute the platform of science laboratory practices. The science laboratory practices are implicated to the extent that it determines students’ attitude change and performance in biology. Inadequate provision of laboratory materials and equipment ideas to under achievement in biology and creates dichotomy between practical’s and theory in the teaching and learning of biology. Also inadequate provision of laboratory equipment and materials do not facilitate positive attitude and attitude change to teaching and learning of biology.
Recommendations

In the light of implications of findings of this study it is recommended that the government and all the stakeholders in Science Education should ensure that there is adequate:

1. Provision of laboratory materials, equipment and facilities.
2. Non-governmental organizations should take interest and bold steps in enhancing the quality of school science laboratories.
3. International donor organizations to assist in equipping school science laboratories.
4. Teachers should be encouraged to attend regular workshops and seminars on improvisation and laboratory techniques.

REFERENCES


