Effects of Biology Practical Activities on Students’ Process Skill Acquisition

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Abstract
This study investigated the effects of biology practical activities on secondary school students’ process skill acquisition in Abuja Municipal Area Council. The design of the study was quasi-experimental; specifically the Pre-test, Post-test, Non Equivalent Control Group Design. A sample of one hundred and eleven senior secondary one (SS 1) biology students randomly drawn from two co-educational schools were used for the study. Two research questions and two null hypotheses guided the study. An instrument known as Science Process Skill Acquisition Test (SPSAT) was used for data collection. The data collected were analyzed using mean, standard deviation and Analysis of covariance (ANCOVA) at 0.05 level of significance. The results revealed that practical activity method was more effective in fostering students’ acquisition of science process skills than the lecture method. There was no interaction between method and gender on students’ process skill acquisition.

Introduction
Science is a great enterprise which nations depend on, in-order to advance technologically. Science therefore, is receiving much emphasis in education because of its significance and relevance to life and society. Biology as a branch of science and the prerequisite subject for many fields of learning contributes immensely to the technological growth of the nation. This includes medicine, forestry, agriculture, biotechnology and nursing. The study of Biology in senior secondary school can equip students with useful concepts, principles and theories that will enable them face the challenges before and after graduation.

Practical activities in biology provide opportunities for students to actually do science as opposed to learning about science. Nzewi (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. Nzewi maintained that practical activities should engage the students in hands-on, mind-on activities, using varieties of instructional materials/equipment to drive the lesson home. Nwagbo (2008: 41) stated that:

The use of practical activities (approach) to the teaching of biological concepts should therefore be a rule rather than an option to biology teachers, if we hope to produce students that would be able to acquire the necessary knowledge, skills and
The search for a more effective approach for the teaching and learning of biology that will enhance the acquisition of process skills has persisted over the years. This is because, the acquisitions of science process skills are the bases for scientific inquiry and the development of intellectual skills and attitudes that are needed to learn concepts. Nwosu in Ibe (2004) asserted that science process skills are abilities which can be developed by experience and used in carrying out mental and physical operations. According to Ibe (2004), the American Association for the Advancement of Science (AAAS) developed a programme known as ‘Science A Process Approach’ (SAPA). This programme sees science processes as true essence of science. The programme was designed to improve children’s skills in the process of science. Ajunwa (2000) reported that science educators and curriculum experts modified them by either expanding or condensing them to suit their special needs or expectations. The Nigerian Educational Research Council in 1990 therefore, modified and came up with fifteen (15) science process skills. These are

I. Observing         II. Measuring
III. Classifying      IV. Communicating
V. Predicting        VI. Inferring
VII. Using number    VIII. Using space/time relationship
IX. Questioning  X  Controlling Variables
XI. Defining operationally  XII. Formulating models
XIII. Hypothesizing  XIV. Designing experiment
XV. Interpreting data

Realizing the importance of science process skills as solution to scientific problems, the Federal Government, among other things, states as one of the national goals of education in Nigeria that: “education should aim at helping the child in the acquisition of appropriate skills, abilities and competencies, both mental and physical as equipment for the individual to live in and contribute to the development of the society” (Federal Republic of Nigeria (FRN), 2004:29). In order to realize this goal, associations, such as Science Teachers Association of Nigeria (STAN) and Nigerian Integrated Science Project (NISP) were set up by the government to look into the various curricula used at various levels of Nigerian educational system. The various curricula developed, have their objectives which have to be achieved for a successful science education and attainment of the national goals and aspirations. These goals and aspirations cannot be realized except through the effective effort of the classroom teacher.

According to Nwagbo (2001), a number of factors have been identified as contributing to the non-acquisition of skills by secondary school students which invariably lead to poor performance and one of the factors is the teacher
variable, that is, the teachers’ method of teaching. Furthermore, Okoli (2006) indicated that many science teachers prefer the traditional expository/lecture method of teaching that is, a teaching technique in which one person, the teacher, presents a spoken discourse on a particular subject and shy away from activity-oriented teaching methods which are student centered (such as inquiry method, discovery method, investigative laboratory approach). Nwagbo (2006) observed that such teacher-centred approach which places the teacher as the sole possessor of knowledge and the students as passive recipients of knowledge may not enhance achievement or promote positive attitude to biology. Apart from teaching methods, gender is also implicated in students’ achievement in science.

The issue of gender and gender stereotyping permeate every aspect of human endeavour. Okeke (2007) observed that the consequences of gender stereotyping cut across social, economic, political and educational development, especially in the areas of science and technology. However, there have been conflicting reports in respect to gender and achievement in science (Abonyi, 1998 and Ezeliora, 1999). This study is therefore expected to contribute to the debate.

Based on the foregoing, the researchers considered it necessary to explore the effects of biology practical activities on students’ acquisition of science process skills and also the influence of gender on acquisition of science process skills.

Science learning is expected to produce individuals that are capable of solving their problem as well as those of the society. Such individuals are expected to be autonomous, confident and self reliant. Science and technology constitute the basis of advancement in nearly all fields of human endeavors. Obiekwe (2008) reported that all is not well with science instruction in Nigerian secondary schools, and noted that science teaching lays extreme emphasis on content and the use of “chalk and talk” method neglecting the practical activity method which enhances teaching and learning. This negligence and ‘shy-away’ attitude from activity oriented- method of teaching has led to abstraction which makes the students less active and more prone to rote memorization. Based on this, the Federal Government of Nigeria is emphasizing “the teaching and learning of science process and principles which will lead to fundamental and applied research in the sciences at all levels of education” (FRN, 2004: 29). A lot has been done to improve science teaching in secondary schools in Nigeria. In spite of that, students continue to perform poorly in science subjects, of which biology is one. This situation has created the need for more effective teaching method. It then becomes necessary to explore the efficacy of alternative method of redressing this situation. Studies have been done on science process skills, but there is no empirical evidence so far, on effects of biology practical activities on students’ process skills acquisition. Therefore, the problem of this study posed as a question is: which of the two teaching methods chosen (practical activity method and
lecture method) better elicits the acquisition of science process skills? The effect of practical activities on acquisition of science process skills of male and female students also poses a problem to be investigated.

Purpose of the Study
The purpose of this study is to determine the effects of biology practical activities on students’ process skill acquisition.
Specifically, the study intends to ascertain:
1. the differential effects of biology practical activities and lecture method on the acquisition of science process skills,
2. the effect of practical activities on science process skills of male and female students.
3. the interaction effect of method and gender on science process skills acquisition of secondary students.

Research Questions
The following research questions guided the study,
1. What is the effect of practical activities on the mean acquisition of science process skills of secondary biology students?
2. What is the effect of practical activities on the mean acquisition of science process skills of male and female biology students?
3. What is the interaction effect of method and gender on the mean acquisition of science process skills of biology students?

Hypotheses
The following null hypotheses were tested at 0.05 level of significance:
HO1: There is no significant difference in the mean science process skill acquisition test score of students taught biology using practical activity method and those taught using lecture method.

HO2: There is no significant difference in the mean science process skills score of male and female students taught biology using the practical approach.

HO3: There is no significant interaction effect of method and gender on the mean acquisition of science process skills of biology students.

Method
The design of this study was Quasi-Experimental. The specific design was Pre-test, Post-test, Non-Equivalent Control Group Design. This design was adopted because intact classes were used as it was not possible to have complete randomization of the subjects.
The sample consists of 111 students from two schools randomly selected from the 17 co-educational secondary schools in Abuja Municipal area council. Simple random sampling (balloting) was used for the study. Only two (2) schools were randomly sampled, due to the experimental nature of the study. One of the schools sampled was assigned to experimental treatment while the other was for control. In each of the schools sampled a stream of SS 1 was randomly sampled for experimental treatment and control respectively.

The instrument used for data collection was Science Process Skill Acquisition Test (SPSAT) developed by the researchers based on the biology topic taught: Animal Nutrition, which was from SS1 biology curriculum. The instrument, SPSAT consists of twenty items designed to measure the level of acquisition of each science process skill. The items were distributed among the process skills of measuring, experimenting, classifying, observing and communicating. SPSAT was used for both pre-test and post – test. It was made up of two sections (A & B). Section A was a practical skills test consisting of practical work while Section B consisted of multiple choice questions with four options A, B, C, D. The use of the practical question for assessment in Section A was based on preference of practical activities over theory questions. In this section, therefore the students were required to demonstrate behaviours such as making careful and accurate measurements, observations, experiments, classifications and communications. Examples of items on practical skill test in section A are as follows:

1. Use your ruler to measure the length of specimen “I”, cut it into two equal size and measure one part again.

2. Smear a drop of the mixture “J” on a piece of white paper, hold the paper against the light, and record your observation and inference. (Use the format below to answer the question).

<table>
<thead>
<tr>
<th>Test</th>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The validation of SPSAT was done by two specialists in Science Education Department, University of Nigeria, Nsukka, and University of Abuja who are experienced science teachers. Split-half reliability technique was used to estimate the reliability of SPSAT. The scores were correlated using Spearman Rank Order Coefficient of Correlation. The split-half reliability coefficient was found to be 0.93.

Experimental Procedure

The regular biology class teachers were used for the study in both experimental and control groups. Training was given to the biology teacher who took the experimental group on the application of the instructional approach.
while the biology teacher who took the control group used the conventional method. Since intact stream was used. The experimental stream teacher was given notes of lesson prepared by the researcher while the researcher vetted the lesson plan prepared by the biology teacher in the control group to ensure that the teacher did not deviate from the procedures of instructions commonly used by biology teachers. Science Process Skill Acquisition Test (SPSAT) was used for both pre-test and post-test. The treatments consist of teaching a selected biology concept: Animal Nutrition using practical activity method. This involved exposition of students to practical/laboratory exercises, use of specimen/materials to concretize learning as well as foster students’ interaction with their environment, the teacher and themselves. The control group was taught the same biology concept using lecture method. Lesson plans for both the treatment and control group were the same in terms of contents, basic instructional objectives, length of time for teaching and mode of evaluation except for practical activities in the treatment group.

At the end of the four (4) weeks of twelve periods, the teacher administered the post test (after reshuffling of the items) to the subjects in the two groups using Science Process Skill Acquisition Test (SPSAT). The scripts from both pre-test and post-test of the two groups were marked and scored using the marking guide.

The data collected from the pre-test and post-test of SPSAT were analyzed using mean and standard deviation for answering the research questions and analysis of covariance (ANCOVA) for testing the hypotheses at 0.05 % level of confidence.

**Results**

Table 1: Mean and Standard Deviation for the Experimental and Control Groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Mean Achievement Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
</tr>
<tr>
<td>Treatment</td>
<td>41</td>
<td>8.146</td>
<td>2.9117</td>
<td>17.3659</td>
</tr>
<tr>
<td>Control</td>
<td>70</td>
<td>7.157</td>
<td>2.3133</td>
<td>10.6714</td>
</tr>
<tr>
<td>Mean Difference</td>
<td></td>
<td>.9892</td>
<td>.</td>
<td>6.69445</td>
</tr>
</tbody>
</table>

Table 1 shows that the experimental pre-test and post-test mean scores are 8.1463 and 17.3659 with standard deviation scores of 2.91171 and of 2.74551 respectively. However the control group has pre-test and post-test mean scores of 7.1571 and 10.6714 with standard deviations scores of 2.31339 and 2.67420 respectively. As shown in Table 1, the mean achievement gain for the treatment group is 9.22 while the mean gain in the control group is 3.51 indicating the superiority of treatment group over the control group in fostering students’ process skill acquisition.
Table 2: Mean and Standard Deviation for the Experimental and Control Groups across the Sex

<table>
<thead>
<tr>
<th>Groups</th>
<th>Sex</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Mean Achievement gains</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
</tr>
<tr>
<td>Treatment</td>
<td>Male</td>
<td>23</td>
<td>8.217</td>
<td>2.6450</td>
<td>17.521</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>18</td>
<td>8.055</td>
<td>3.2983</td>
<td>17.166</td>
</tr>
<tr>
<td></td>
<td>Mean Difference</td>
<td>-1.618</td>
<td>.3550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Male</td>
<td>37</td>
<td>6.837</td>
<td>2.2300</td>
<td>10.891</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>33</td>
<td>7.515</td>
<td>2.3864</td>
<td>10.424</td>
</tr>
<tr>
<td></td>
<td>Mean Difference</td>
<td>-1.3226</td>
<td>.4677</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows that the pre-test mean scores and standard deviation score for the experimental male and female are 8.2174 and 2.6450; 8.0556 and 3.29835 respectively. Similarly, the post-test mean scores and standard deviation scores for the experimental male and female groups are 17.5217 and 2.72813; 17.1667 and 2.83362 respectively. Also, the pre-test means scores and standard deviation scores for the control male and female are 6.8378 and 2.23002; 7.5152 and 2.38644 respectively. Also, the post-test mean scores and standard deviation score for the control male and female are 10.8919 and 2.13156; 10.4242 and 3.19208 respectively. The mean achievement gains for males and females in the treatment group are 9.30 and 9.11 respectively. In the the control group the gains are 4.05 and 2.91 respectively for males and females.

Table 3: Test of interaction between method and gender on students' science process skill acquisition.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Treatment (mean gain)</th>
<th>Control (mean gain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>9.30</td>
<td>4.05</td>
</tr>
<tr>
<td>Females</td>
<td>9.11</td>
<td>2.91</td>
</tr>
</tbody>
</table>

As shown in Table 3, the mean achievement gains are higher at the two level of gender (male and females) in the treatment group than in the control group. This implies there is no interaction between gender and methods on students process skill acquisition.
Table 4: Summary of ANCOVA Table

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>1164.896(a)</td>
<td>4</td>
<td>291.224</td>
<td>39.135</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>2007.870</td>
<td>1</td>
<td>2007.870</td>
<td>269.821</td>
<td>.000</td>
</tr>
<tr>
<td>Pretest</td>
<td>1.069</td>
<td>1</td>
<td>1.069</td>
<td>.144</td>
<td>.705</td>
</tr>
<tr>
<td>Group</td>
<td>1093.965</td>
<td>1</td>
<td>1093.965</td>
<td>147.009</td>
<td>.000</td>
</tr>
<tr>
<td>Sex</td>
<td>4.532</td>
<td>1</td>
<td>4.532</td>
<td>.609</td>
<td>.437</td>
</tr>
<tr>
<td>Group * Sex</td>
<td>.134</td>
<td>1</td>
<td>.134</td>
<td>.018</td>
<td>.893</td>
</tr>
<tr>
<td>Error</td>
<td>788.798</td>
<td>106</td>
<td>7.441</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21131.000</td>
<td>111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>1953.694</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 shows that F (147.009) is significant at .000 for the methods, at 1 and 110 degrees of freedom (Df). This is because, .000 is less than .05 significant level earlier set for the hypothesis. Hence, the hypothesis is not accepted. That is, there is significant difference between the science process skills acquisition test scores of students taught biology using practical activities method and those taught using lecture method.

Table 4 shows that F (.609) is not significant at .437 for the sex, at 1 and 110 degrees of freedom (df). This is because, .437 is more than .05 significant level earlier set for the hypothesis. Hence, the hypothesis is accepted. That is, there is no significant difference between the male and female student’s mean scores on a science process skills acquisition test (SPSAT).

H03: There is no significant interaction effect of method and gender on the mean acquisition of science process skills of biology students.

Table 4 shows that F (.018) is not significant at .893 for the interaction between groups and sex at 1 and 110 degrees of freedom (Df). This is because, .893 is more than .05 significant level earlier set for the hypothesis. Hence, the hypothesis is not rejected. There was no significant interaction effect between the teaching methods and gender of the subjects, in acquisition of science process skills as measured by science process skill acquisition test (SPSAT).

Summary of the Findings
From the results, the following are the summary of the findings
1. Practical activity method fosters the acquisition of science process skills better than lecture method.
2. There was no significant interaction between the teaching methods and gender.
3. There is significant difference between the science process skills acquisition test scores of students taught biology using practical activities method and those taught using lecture method.
4. There is no significant difference between the male and female student’s mean scores on a science process skills acquisition test (SPSAT).

Discussion

The students in the experimental group had a higher mean Science Process Skill Acquisition Test (SPSAT) score in biological concept compared to their control group counterparts. This shows that method of instruction helped the students to acquire the necessary science process skills better. The active involvement of students in practical activities may have given rise to efficient learning, which accounted for the reported significant effect in acquisition of science process skills.

The results of this study were in line with the views of previous researchers like, (Nwosu, 1991; Mandor, 2002 and Ibe, 2004) who indicated that active participation of the students gave rise to more meaningful and effective learning.

In the case of gender, the findings of this study revealed that male students has a higher mean score than their female counterparts in SPSAT although the difference was not significant. That was further confirmed by the ANCOVA result in table 4 which revealed that gender was not a significant factor on students’ acquisition of science process skill when taught with practical activity method. This result agrees with the findings of (Ibitoye, 1998 and Abonyi, 1998) who found no significant difference in the achievement of male and female in science subjects.

The findings also revealed that there was no interaction between teaching methods and gender of the subjects to influence students’ acquisition of science process skills. This was further confirmed by ANCOVA result in Table 4 which shows that the interaction effect between teaching methods and gender of the students were not significant, implying that gender did not combine with teaching methods to affect the students acquisition of science process skills. This result is in agreement with the findings of Iloputaife (2001) and Ibe (2004) who found no significant interaction between instructional method and gender on performance.

Educational Implications of the Findings

The findings of this study have some educational implications for students, teachers and curriculum planners.

Active participation of the students in the class aids retention and makes the lesson more meaningful. This is because as the students participate and manipulate equipment/materials, they apply their five senses and other skills to their lessons more than when they would have learned in abstraction or remained less active in the class.

The findings of this study have implications on the teachers who should adopt practical activity method of teaching which is the student centered method.
Students learn better when they are involved in the activity. Activity-based methods enhance understanding of biological concepts and increase the ability to acquire science process skills by the learner.

The findings of this study also have implication on the curriculum planners who are expected to plan for conceptual change over period of years. This is because learning involves the restructuring of prior knowledge to gain new ones for effective learning to take place. Therefore, since the use of practical activities enhances students acquisition of science process skills, it follows that curriculum planners can create the awareness of this method in teachers by including it in the biology curricula. Also, they should include within the existing subjects contents of the biology curriculum, some corresponding indigenous knowledge. They can do this by re-examining the existing units of the subject matter taught in schools and identifying their corresponding indigenous knowledge and instructional material. This will make the teaching of biology interesting and more meaningful to the students.

Limitations of the Study
The findings, conclusions and generalization of this study may have been affected by a number of limiting factors. Some of the limiting factors which may have affected this study are:
1. Only five science process skills were tested out of the fifteen identified by the American Association for the Advancement of Science, AAAS. Therefore, the findings of this study may not be generalized.
2. The researcher used only one area council education zone out of the six area councils in Abuja FCT. Generalizing information obtained from one area council to the other remaining five is a limitation.
3. The population of this study was limited to students in the Senior Secondary One (SSI) from the selected schools: Government day secondary school Wuse II and Government secondary school Lugbe.

Conclusion
Based on the findings of the study on the effects of biology practical activities on students’ process skill acquisition in Abuja Municipal area council, the following conclusions were made.
1. Practical activity method enhanced and facilitated the acquisition of science process skills more than the lecture method.
2. Practical activity method fosters acquisition of process skills in both male and female students.
3. There was no significant interaction effect between teaching methods and gender of the subjects, in acquisition of science process skills as measured by science process skill acquisition test (SPSAT).
Recommendations
1. Teachers should encourage students to develop interest in practical activities by engaging them in practical and providing instructional materials that will challenge them to be actively involved during practical lessons.
2. Ministry of Education and professional organizations like STAN should organize workshops, seminars and conferences for biology teachers.
3. Biology concepts should be taught with practical activity so that the students will do science instead of learning about science.

References


