EXPERIMENTAL STUDY OF INQUIRY TEACHING METHOD AND STUDENTS’ ACHIEVEMENT IN BIOLOGY.

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Abstract
The study investigated the effect of inquiry teaching method on secondary school students’ academic achievement in biology. One research question and three hypotheses tested at 0.05 level of significance guided the study. The design of the study was quasi-experimental with 116 Senior Secondary students selected purposively from two senior secondary schools in Adamawa state, Nigeria. Instrument used for data collection was an achievement test tagged Biology Students’ Achievement Test (BSAT) adapted from WAEC tests from 2005-2010. The instrument was content validated by three experts and Cronbach alpha Formula was used for testing its reliability. The reliability coefficient of 0.78 was obtained. The treatment lasted for six weeks and data were analyzed using descriptive statistics and Analysis of Covariance (ANCOVA). The result of the study revealed that, inquiry and lecture methods enhanced students’ achievement in biology while, the inferential statistics revealed that, students taught biology with inquiry teaching method performed better than those taught with lecture method. Furthermore, students’ achievement did not differ based on gender. It was recommended that, inquiry teaching methods should be incorporated in the teaching of biology, and practicing teachers should be expose to inquiry teaching method.

Keywords: Inquiry, Gender, Achievement, Secondary School, Biology.

INTRODUCTION

Biology as a subject in secondary school, had witnessed a high enrolment rate compared to any other science subject in the final year external examination (Oguzor & Opara, 2011). Contrarily, there has not been a corresponding increase in students’ academic achievement in the examinations. The output of students’ final year academic achievement, has been consistently low as revealed by the following 2012-2014 May/June Senior Secondary Certificate Examination result.

Table(1) Summary of WAEC Results from 2012-2014

<table>
<thead>
<tr>
<th>Year</th>
<th>A1-C6</th>
<th>D7-F9</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>38.81%</td>
<td>61.19%</td>
</tr>
<tr>
<td>2013</td>
<td>36.57%</td>
<td>63.43%</td>
</tr>
<tr>
<td>2014</td>
<td>31.28%</td>
<td>68.72%</td>
</tr>
</tbody>
</table>

Source: chief examiner’s report 2014.

Several studies have investigated the causes of the appalling state of students’ performance in biology in secondary schools. These causes were identified as; in availability of biology text books, laboratory apparatus and other learning resources contribute significantly to the poor performance of students in Biology (Samikwo, 2013). He also added that, students’ attitude towards the biology subject also affect their performance. Occupation of parents also influences students’ academic achievement in biology (Suman, 2011). Educational qualification of parents and health status of students are significant among factors that affect the academic performance of students in biology (Femi & Adewale, 2012; Akinsanyo, Ajayi & Salomi, 2014). Various researchers such as (Thors and Myers, 2009; Ozdilek and Bulunuz, 2009; Neuby, 2010; Oguzor and Opara, 2011; Striclyn, 2011; Edingyang and Ubi, 2012; Ali, Toriman & Gosim, 2014; Abdi, 2014 & Njoroge, Changijeowo & Ndirigu, 2014) attributed the poor performance of students in Senior Secondary school Certificate Examination (SSCE) to ineffective methods of teaching.

Biology teachers in secondary schools need to change their teaching approaches to make them more effective and relevant to a much larger proportion of the student population. According to Okoro (2002) in many countries particularly in the developing countries, biology education in schools do not seems to help students achieve scientific and technological literacy or feel confident either in applying their knowledge or dealing with societal problems. Therefore, to achieve meaningful learning, appropriate strategies, methodologies or techniques of teaching becomes very necessary. Kalia (2005) reported that, biology teaching generally conforms to the conventional methods and continues to be dominated by teacher making it as dull and uninspiring as ever before. The traditional lecture method is not satisfying the needs of individuals entering careers in biology, attending major universities, or pursuing other postsecondary education endeavours (National Research Council, 2009). Okebukola in Oguzor and Opara (2011) pointed out that, many teachers behave base on their training and they lack an understanding of the basic nature and aims of science. Teachers also have a problem of “teach as you were taught” and with this didactic “copy and teach” and “chalk and talk” teaching methods and unfavorable teaching environment, the science taught in the conventional classroom is a mere “web of thought too weak to furniture support but complicated enough to cause confusion” (Opara, 2011).

Edingyang and Ubi (2012) opined that, lecture is probably the oldest instructional format and today it is still the most common form of instruction. Lecture method is usually dominated by direct and unilateral instruction from the teacher. Teachers who teach with traditional lecture method assume that there is a fixed body of knowledge that the student must come to attained (Stofflelt as cited by Abdi, 2014). In traditional lecture method the teacher expects the students to blindly accept the information they are given without questioning. The teacher seeks to transfer thoughts and meanings to the passive student leaving little room for student-initiated questions, independent thoughts or interactions between students (Abdi, 2014). Even in the activities based subjects like biology, although activities
are done in a group but do not encourage inquiring or exploration of the concepts involved. This teacher-centered method of teaching also assumes that all students have the same level of background knowledge in the subject matter.

However, Thoron and Myers (2012) found out that, traditional lecture–based teaching is creating learners that lack the ability to develop arguments with adequate evidence and the learners are now less likely to link evidence with claims. Furtak (2006) opined that there is a continuum of different methods of science teaching. At one side of the continuum, there is a direct lecture instruction didactic technique where the teacher tells factual information to learners. At the other side of the continuum there is open-ended scientific inquiry where learners design and conduct their investigations by themselves. In the more open ended approaches to inquiry-based instruction, there might be problems such as whether the students are clear about the learning intention and whether they have suitable cognitive skills. Guided inquiry teaching takes place somewhere between the two extremes, where students are guided through a process of scientific investigation by the teacher. This method is a student-centered and activity-based teaching strategy where a teacher uses a variety of instructional materials to help students discover possible and testable solutions to their defined scientific investigations (Nwagbo, 2006). According to the 1996 National Science Education Standards developed in the U.S. National Research Council (NRC, 1996), “teaching science as inquiry provides teachers with the opportunity to develop student abilities and to enrich student understanding of science” (p. 121).

The NRC (2000) stated that inquiry–based instruction is the optimal tool to provide students with the ability to transfer knowledge to real–world applications. The interactions that students have with themselves and their teacher during this teaching method may lead to better communication skills and consequently may lead to better performance. Edingyang and Ubi (2012) found out that, students taught with inquiry teaching method performed significantly better than their counterparts taught with the expository teaching method this is because students taught with inquiry method have physical involvement in the lesson. Based on their findings Edingyang and Ubi recommended that, the better performance of students in the post-test where inquiry method was used implies that as much as possible, teachers should endeavour to use inquiry method in teaching. Along the same vein Hussain, Azeem and Shakoor (2011) found out that students taught with inquiry teaching method performed significantly better than their counterparts who taught with traditional lecture method. In inquiry-based method of teaching, children become engaged in many activities and thinking processes in order to produce new knowledge. Science educators encourage secondary school teachers to replace traditional lecture method with inquiry-oriented approaches that (a) engage student interest in biology, (b) provide opportunities for students to use appropriate laboratory techniques to collect evidence, (c) require students to solve problems using logic and evidence, (d) encourage students to conduct further study to develop more elaborate explanations, and (e) emphasize the importance of writing scientific explanations on the basis of evidence (Secker in Abdi, 2014). However there are very little research efforts in the use of these methods in teaching biology.

Statement of the Problem

A number of teaching strategies have been employed in teaching biology for over two decades not much effort seems to have been made towards finding out the effectiveness of the instructional methods used by biology teachers (Oghenewede, 2010). A lot of innovative instructional methods including guided discovery, cooperative learning, science-technology-society, analog, constructivist, inquiry, programmed instruction, concept mapping have been suggested for teaching but records show that there is a trend of poor performance by secondary school students in biology. This has been an issue of serious concern to the researcher, thereby necessitated this study on - Inquiry Teaching Method and Students Achievement in Biology.

Research Question

What is the post test mean score of students in biology when taught using inquiry and lecture methods of teaching?

Hypotheses

Three hypotheses were stated and tested at 0.05 level of significance

$H_O_1$: There is no significant main effect of treatment on students’ academic achievement in biology when taught biology using inquiry and lecture methods of teaching.

$H_O_2$: There is no significant main effect of gender on students’ academic achievement in biology when taught biology using inquiry and lecture methods of teaching.

$H_O_3$: There is no significant interaction effect of treatments and gender on students’ academic achievement in biology when taught biology using inquiry and lecture methods of teaching.

METHODOLOGY

The study adopted the quasi-experimental pre-test, post-test non-equivalent control group design. The study was conducted in Adamawa State, Nigeria. The target population of the study was all Senior Secondary two (SSII) students in senior secondary schools in Adamawa state offering biology. The reason for using SSII students was because the class is stable. It is neither facing the problem of being freshly introduced to senior secondary biology (as is the case with SS1) nor preparing for any end of course or terminal examination (as is the case with SSIII). The sample for the study consisted of 66 male and 50 female SSII biology students from two public co-educational senior secondary schools in Girei local government area of Adamawa State. Purposive sampling technique was used to select the co-educational schools for the study. Two intact classes were chosen randomly from each of the schools. The intact classes in each of the schools were assigned randomly to one experimental and control group. The experimental group is inquiry method group while the control group is the lecture method group.

The instrument for data collection was an achievement test tagged the “Biology Students’ Achievement Test” (BSAT). The BSAT is a 60-itemed multiple-choice objective test items with four options. The instrument was adapted from West African Examination Council (WAEC) biology past questions from 2005-2010. The items covered six cognitive domains of educational objectives (Knowledge contains 25% of the items, comprehension 25%, application 15%, analysis 15%, synthesis 10%, while evaluation takes 10%). The instrument was pilot-tested on 30 students from a non-participating school. The BSAT yielded a Cronbach alpha reliability index of 0.78 which was a good reliability index.

The pre-test was administered in the first week of the research exercise to both the experimental and control groups before the treatment. The treatment was done strictly on selected topics drawn from senior secondary school II syllabus which included: Nutrition, Habitat and Nutrient cycle. The experimental group was subjected to treatment of inquiry method, while the control group was taught using
what the lecture method. The class teaching was done by one of the researchers. Posttest was administered to both the experimental and control groups after six weeks of instruction. The hypotheses were tested at 0.05 level of significance using one-way Analysis of Covariance (ANCOVA).

ANALYSIS AND RESULT

Research Question

What is the post test mean score of students in biology when taught with inquiry and lecture methods of teaching?

Table (2) Descriptive Statistics of Students’ Score.

<table>
<thead>
<tr>
<th>Teaching method</th>
<th>Gender</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry</td>
<td>Male</td>
<td>36.29</td>
<td>6.16</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>37.38</td>
<td>5.96</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36.83</td>
<td>6.06</td>
<td>56</td>
</tr>
<tr>
<td>Lecture</td>
<td>Male</td>
<td>28.62</td>
<td>6.37</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>33.16</td>
<td>4.89</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30.52</td>
<td>6.17</td>
<td>60</td>
</tr>
</tbody>
</table>

The descriptive statistics in Table 2 revealed that the mean score of the students taught with inquiry method was 36.83 with a standard deviation of 6.06 while the control group taught with lecture method has mean score of 30.51 with standard deviation of 6.17. In the experimental group females performed slightly better with the mean score of 37.38 and standard deviation of 5.96 than their males counterpart have mean score of 36.29 with standard deviation of 6.16. This indicates that experimental group performed better than the control group while females performed slightly better than males in the experimental group.

Hypotheses

H01. There is no significant main effect of treatment on students' academic achievement in biology when taught biology with inquiry and lecture methods of teaching.

The results of the analysis in Table 3 revealed that, there is significant main effect of treatment on students' academic achievement $F = 38.3$ (df 1), $P = 0.000$. Since the computed $p$-value (0.000) is less than 0.05 level of significant, the null hypothesis of no significant effect is rejected, meaning there is significant effect of treatment on students' academic achievement in biology in favour of inquiry method as indicated by their mean score in Table 1. Also, there was strong relationship between pretest and post test scores as indicated by partial eta squared value of 0.26 according to guideline proposed by Cohen (1988). This shows that 26% of the variances were due to the teaching methods.

H02. There is no significant main effect of gender on students' academic achievement in biology when taught biology using inquiry and lecture methods of teaching.

From the Table(3), the main effect of gender on students' academic achievement in biology was significant $F = 11.2$ (df 1), $P = 0.061$. Since the computed $p$-value (0.061) is greater than 0.05 level of significant, the null hypothesis of no significant effect is accepted. This means gender did not affect students' academic achievement significantly when these teaching methods are used. The partial eta of 0.012 indicates that gender contributed only 1% variances on students' academic achievement.

H03. There is no interaction effect of treatments and gender on students’ academic achievement in biology when taught biology using inquiry and lecture methods of teaching.

From the Table(3), also the interaction effect of treatment and gender on students’ academic achievement was not significant $F = 676$ (df 1), $P = .413$. Since the computed $p$-value (0.413) is greater than 0.05 level of significant, the null hypothesis of no significant effect is accepted; meaning the interaction of teaching methods and gender on students’ academic achievement is not significant. The partial eta of 0.006 indicates that the interaction contributed only 0.6% variances on students’ academic achievement.

Table (3) Two-way Analysis of Covariance of Students’ Achievement

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>MS</th>
<th>DF</th>
<th>F</th>
<th>Sig.</th>
<th>PES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>1870.681</td>
<td>467.670</td>
<td>14.049</td>
<td>.000</td>
<td>.336</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>4243.003</td>
<td>1</td>
<td>4243.003</td>
<td>127.458</td>
<td>000</td>
<td>535</td>
</tr>
<tr>
<td>Pretest</td>
<td>87.447</td>
<td>1</td>
<td>87.447</td>
<td>2.627</td>
<td>108</td>
<td>023</td>
</tr>
<tr>
<td>Treatment</td>
<td>1275.100</td>
<td>1</td>
<td>1275.100</td>
<td>38.304</td>
<td>000*</td>
<td>.257</td>
</tr>
<tr>
<td>Gender</td>
<td>373.198</td>
<td>1</td>
<td>373.198</td>
<td>11.211</td>
<td>061</td>
<td>.012</td>
</tr>
<tr>
<td>Treatment * Gender</td>
<td>22.515</td>
<td>1</td>
<td>22.515</td>
<td>.676</td>
<td>413</td>
<td>.006</td>
</tr>
<tr>
<td>Corrected total</td>
<td>5565.793</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .336 (Adjusted R Squared =3.12)

DISCUSSION

This study is part of a larger study conducted by the researchers. The results address the objectives and hypothesis of the study in determining the influence of inquiry teaching method and gender on students’ academic achievement in biology. The findings of this study are discussed under instructional methods and students’ academic achievement in biology. Firstly, the result of the study revealed that the inquiry and lecture groups of students did not perform academically better than one another at the pretest level. Secondly, the result of the study also revealed that the inquiry group of students performed significantly better than the lecture group of students at the post-test level. With regard to the equal academic performance of both the inquiry and lecture group of students in the pretest level, invariably, one could not have expected anything different in their achievement. This is because the selected groups were randomly assigned to the experimental and control groups, and none of them was exposed to any lesson before the pretest was administered. None of the groups was given any special treatment in terms of selection as well. Thus, none of the groups was therefore expected to have an edge over the other at the pre-test.

Furthermore, the students in the inquiry group of the study performed significantly better than their counterparts in the lecture group of the study because of their physical involvement in the lesson and the teachers’ teaching technique. The result of this study agrees with the studies of Ozdilek and Bulunuz (2009), Khan and Iqbal (2011), Hussain, Azeem and Shakoor (2011), Opara (2011), Thoron and Myer (2012), Edinyang and Ubi (2012), Mathew and Kenneth (2013), Abdi (2014), Njoroge, Changeiywo and Ndirangu (2014). They agree that students learn more and comprehend better when they are actively involved in the lesson. This is because any teaching procedures which involve students in some positive activity, as did the inquiry, are generally more effective than any other method which does not give room for learners’ active participation as epitomized in the case of the lecture method of teaching biology. Experiences of practicing teachers have revealed that facts obtained by students in the inquiry class have higher rotational values than facts merely dictated to students by the teachers (Edinyang and Ubi, 2012). This might be due to the inter-activeness and friendliness that the inquiry method provides for the students. Students in the inquiry
group were better motivated to learn; this might be as a result of the discipline of having to and respect the opinion of others during discussion having discovered that knowledge does not belong to only a person.

Another major finding of this study is that there is no significant interaction effect between the teaching methods and gender on students’ academic achievement in biology. This implies that a combination of inquiry and lecture methods with gender do not have any effect on the achievement of students. As pointed out by Oghenevwede (2010) that a teacher is free to choose his method once he believes in the efficacy of the method in achieving the aims and objectives. It can be concluded that if the right instructional method is combined with students ability the students will achieve better in biology irrespective of their gender.

Similarly, the findings reported that, there is no gender difference on the post test score of students. Many studies with inquiry teaching method revealed gender equity in biology such as (Opara, 2011; Hussain, Azeem & Shakoor, 2011; and Njoroge, Changeiuyo & Ndirangu 2014). This is not unconnected with the recent discovery of cooperative teaching methods like inquiry where the students work in groups in order to solve scientific problems.

CONCLUSION

It was concluded that, inquiry teaching method is better than lecture method. Similarly, there was no gender difference in students’ academic achievement in biology when taught biology using inquiry method.

Recommendation

From the result of this study, the following recommendations are made:

a) It is evident that, inquiry teaching method is effective in improving students’ achievement in biology, Therefore, teachers should use the teaching methods to facilitate their biology teaching.

b) Pre-service teachers should be exposed to the inquiry teaching method.

c) Inquiry teaching method should be suggested for some biology content areas in the curriculum.

References


