EFFECT OF CONCEPT MAPPING AND INQUIRY TEACHING METHODS ON SECONDARY SCHOOL STUDENTS’ ACADEMIC ACHIEVEMENT IN BIOLOGY.

John Sakiyo, *Kawu Waziri
Science Education Department, School of Technology and Science Education, Modibbo Adama University of Technology, Yola, Nigeria.
Email: kawuwaziri@rocketmail.com

Abstract
The study investigated the effect of concept mapping and inquiry teaching methods on secondary school students’ academic achievement in biology. Two hypotheses tested at 0.05 level of significance guided the study. The design of the study was quasi-experimental design with 176 Senior Secondary two students from three purposively selected senior secondary schools in Adamawa state. Instrument used for data collection was an achievement test tagged Biology Students’ Achievement Test (BSAT) adapted from WAEC past questions 2005-2010. The instrument was content validated by three experts and was tested for reliability using cronbach alpha method. The reliability coefficient of 0.78 was obtained. The treatment lasted for six weeks and data were analyzed using Analysis of Covariance (ANCOVA). The result revealed that, concept mapping, inquiry and lecture methods enhanced students’ achievement in biology. Furthermore, there was no significant effect of gender on the students’ academic achievement in biology, post hoc analysis revealed that, concept mapping is better than inquiry and lecture, while inquiry is better than lecture method. It was recommended that, concept mapping and inquiry teaching methods should be incorporated in the teaching of biology, workshop should organize for practicing teachers.

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

INTRODUCTION
Biology has witnessed a high enrollment compared to any other science subject in the final year external examination (Sakiyo, 2014). Despite the high enrollment rate there has not been corresponding increase in students’ academic achievement and in spite of the efforts of both federal and state governments to encourage biology education, students’ failure in biology in Senior Secondary Certificate Examination (SSCE) is high (Nwogbor, 2001; Oguzor and Opara, 2011; Sakiyo, 2014). One of the major reasons for this poor performance could be attributed to ineffective methods of biology instruction adopted by Nigerian secondary school teachers (Orji and Ebele, 2006). Nwagbor (2001) reported that teachers shy away from the more effective activity-oriented teaching methods like inquiry, concept mapping, constructivist, analogy and Science Technology Society (STS) methods in preference to lecture method which is easy and mostly inadequate and inappropriate.

Many of the methods of conveying knowledge have been shown to be relatively ineffective on the students’ ability to master and retain concepts. The manner in which biology subject is presented to students can negatively influence their achievement, the presentation should be activity-based rather than teacher-centred based. The use of lecture method entails a one way flow of communication from the teacher to the students, the method is a teacher-centered approach where most of the talking is carried out by the teacher while the students remain as passive listeners taking down notes. Most of the teaching carried out in our schools today is through the use of lecture method, which according to Okebukola (1995) is passive rather than active and do not foster critical and creative thinking. Many teachers prefer the use of lecture method as revealed by Nwezi (2009) because it does not require the use of instructional materials or resources, to this effect, the students are denied the opportunity of developing manipulative skills. However, Agbogboro (2009) pointed out that despite the existence of learning theories most teachers still dispense information using lecture method without regard to students’ learning abilities. It is now being recognized that there are better ways to teach than through the lecture method of instruction.

Concept mapping as a strategy in education is parallel with the movement from teacher to learner-centred method which has the power to improve academic achievement (Peterson and Snyder, 2008). Concept mapping has been widely recommended and used in a variety of ways. It has been used to help teachers and students build an organized knowledge based on a given discipline or on a given topic (Blackwell & Pepper, 2008). It has also, been used to facilitate middle level students’ learning of science content (Novak & Gowin, 1994; Adlaon, 2002; Dhaaka, 2012). Findings from these studies indicate that concept mapping is an effective tool for aiding students’ comprehension and retention of science materials. Jegede cited in Nnamdi and Okechukwu (2006) showed that the use of teaching strategies like concept mapping and problem solving methods increases achievement and reduces both male and female students’ anxiety. Moreover, Chee and Wong (1996) recommended that, giving students more chance to get involved in the learning process through the use of concept mapping and problem solving skills makes them perform significantly better than their counterparts who have been exposed to the lecture method. It has also became clear that for students who have some concept mapping experience, there exists a correlation between their concept mapping ability and performance in achievement test.
Inquiry teaching method according to Okebukola (1995) has opportunity to engage in interaction relevant to the accomplishment of the learning task. Students make decisions by consensus and seek help and assistance primarily from each other. Thus, students’ goal achievement is positively correlated; when one student achieves his or her goal, all students with whom he or she is cooperatively linked achieve their goals. Inquiry learning environment is very acceptable and favourable to girls who are thus encouraged to get involved and achieve better in biology (Burns and Bird, 1997). Based on this, it is clear that girls perform well in cooperative inquiry class. Schleker (1996) reported that inquiry training resulted in increased understanding of science productivity in creative thinking and skills for obtaining and analyzing information. Schleker reported that inquiry teaching method was more effective than conventional lecture method of teaching in the acquisition of information. Ivany (2009) and Collins (2006) reported that inquiry method works best when the confrontations are strong, arousing genuine puzzlement and when the materials the students use to explore the topics under consideration are especially instructional. Inquiry instruction encourages students to extend their thinking and express their ideas in a variety of ways (Schneider and Orji, 2001). It is indicated by some researchers (Geban et al, 1992; Berenfeld, 1996; Henkel, 1998; Basaga et al, 2004; Ertepinar and Geban, 2006) that inquiry teaching results in greater student achievement and positive science attitudes more than the lecture method. On the other hand, some researchers (Germann, 1999; Oliver, 2005; Orr, 2008) found out that, inquiry teaching strategy has no significant effects on the achievement or learning of science process skills. Hence, the effectiveness of inquiry teaching method is contentious.

There have been conflicting reports in respect to gender and achievement in science (Ezeliora, 1999). According to many studies males have higher academic achievement in science than females (Johnson, 2001; Simpson and Oliver, 2005; Okigbo and Okeke, 2011). On the other hand, Weinburgh and Englehard (1994) found out that, females had better academic achievement in biology laboratory than males. While, Sakiyo (2008) found no significant difference on students’ achievement based on gender. Sakiyo (2007) recommended that, gender differences can be eliminated when teachers used certain teaching strategies that can bring about gender equity in science education. In summary, more research on gender differences in academic achievement is needed to make conclusive implications of the impact that gender may have on students’ academic achievement.

Statement of the Problem

Students’ academic achievement has been a focus of many studies examining the effects of interaction pattern on learning outcomes (Orji and Ebele, 2006). Many factors were reported to contribute for the students’ poor academic achievement in biology, but Orji and Ebele (2006) attributed students’ poor academic achievement to ineffective methods of biology instruction adopted by Nigerian secondary school teachers. For this reason, Okebukola (1998) and Katcha (2004) recommended the need for more studies in teaching methods that can improve students’ academic achievement in biology. It was based on this problem that the researchers investigated the effect of concept mapping and inquiry teaching methods on secondary school students’ academic achievement in biology in Adamawa State, Nigeria.

Hypotheses

Two hypotheses were stated and tested at 0.05 level of significance

HO1. There is no significant effect of treatment on students’ academic achievement in biology when taught biology using concept mapping, inquiry and lecture methods of teaching.

HO2. There is no significant effect of gender on students’ academic achievement in biology when taught biology using concept mapping, 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 SSII students in senior secondary schools in Adamawa state offering biology. The reason to use of 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 SSII) nor preparing for any end of course or terminal examination (as is the case with SSIII). The sample for the study consisted of 89 male and 87 female SSII biology students from three co-educational senior secondary schools in Adamawa State. Purposive sampling technique was used to select the co-educational schools for the study. One intact class was chosen randomly from each of the schools. The schools were then assigned randomly to two experimental and one control groups. The experimental groups are concept mapping and Inquiry groups 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 makes 10%). The instrument was pilot tested on 50 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 groups were subjected to treatment of concept mapping and inquiry methods, while the control group was taught using 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 Two-way Analysis of Covariance (ANCOVA). Post hoc analysis was done as the computed ANCOVA value was significant.

RESULTS

HO1. There is no significant effect of treatment on students’ academic achievement in biology when taught biology using concept mapping, inquiry and lecture methods of teaching.
The results of the analysis in Table 1 revealed that, there is significant effect of treatment on students’ academic achievement \( F = 41.77 \) (df 2), \( P = 0.000 \). Since the computed value is less than 0.05 level of significant, the null hypothesis of no significant effect is rejected, which means there is significant effect of treatment on students’ academic achievement in biology. Also, there was strong relationship between pretest and post test scores as indicated by partial eta squared value of 0.33 according to guideline proposed by Cohen (1988). This shows that 33% of the variances were due to the teaching methods.

**Multiple Comparison Analysis**

Hypothesis 1, revealed significant effect of treatment on students’ academic achievement in the three groups (concept mapping, inquiry and lecture), this indicates that the three teaching methods may not be equally effective. It is therefore important to compare the three groups two-by-two to find out the group(s) that caused the significant effect. This is why Table 2 is important.

**Table 2. Bonferroni Multiple Comparisons of Teaching Methods (Post Hoc Analysis)**

<table>
<thead>
<tr>
<th>Teaching Method</th>
<th>Mean Difference (I–J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept mapping</td>
<td>5.7643*</td>
<td>1.52415</td>
<td>.001*</td>
</tr>
<tr>
<td>Inquiry</td>
<td>13.5235</td>
<td>1.48651</td>
<td>.000*</td>
</tr>
<tr>
<td>Lecture</td>
<td>7.7593</td>
<td>1.50085</td>
<td>.000*</td>
</tr>
<tr>
<td>Inquiry</td>
<td>-13.5235</td>
<td>1.48651</td>
<td>.000*</td>
</tr>
<tr>
<td>Lecture</td>
<td>-7.7593</td>
<td>1.50085</td>
<td>.000*</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

The results in Table 2 indicated that, there was significant mean difference between concept mapping and inquiry methods with a mean difference of 5.76. There is also significant difference between concept mapping and lecture methods with a mean difference of 13.52. There was significant difference between inquiry and lecture methods with a mean difference of 7.75. Hence, concept mapping method is significantly better than inquiry method and lecture methods. While, inquiry method is significantly better than lecture method.

**H02.** There is no significant effect of gender on students’ academic achievement in biology when taught biology using concept mapping, inquiry and lecture methods of teaching.

From the Table 1, the effect of gender on students’ academic achievement in biology was not significant \( F = 0.448 \) (df 1), \( P = 0.504 \). Since the computed value (0.504) 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 0.003 indicates that gender contributed only 3% variances on students’ academic achievement.

**DISCUSSION**

The findings of the study revealed that, there was a significant difference between concept mapping, inquiry and lecture methods. It was found out that the use of student-centred teaching methods like concept mapping and inquiry methods in biology makes it possible to have an interactive lesson. The level of students’ achievement improved significantly in the experimental groups after the treatment. Stephen and Stephen (2005) reported that, the use of learner-centred teaching methods increased students’ achievement in biology.

The study also found out that, Students taught biology contents using concept mapping method performed better than those taught with inquiry and lecture methods. This means concept mapping is the best teaching method among the three teaching methods. This finding agrees with findings of Akeju, Simpson, Rotimi and Kenni (2011) who found significant difference in favour of concept mapping group, it was revealed that, concept mapping instructional strategy contributed to learning achievement in biology. Yezka and Nasrabad (2004) also found out that concept mapping has a significant difference when used on nursing students in Iran.

The study also found out that, students taught biology contents using inquiry method performed better than those taught with lecture method. This finding is similar with that of Hussain, et al. (2011) who revealed that, there is significant effect of guided, unguided and combination scientific inquiry on the students’ achievement than traditional lecture method and their proficiency to apply the concepts of chemistry in real situations. Similarly Khan and Iqbal (2011) found similar result in Pakistan and it was observed that the students taught through inquiry teaching method showed better performance in science process skill than the students of the control group taught through the traditional teaching method.

The study also found out that, gender did not affect students’ achievement in biology. Hussain, at al. (2011) reported lack of significant gender difference when inquiry teaching method was used on students’ achievement Similarly, Dhaka (2012) used concept mapping strategy to determine its effectiveness on students performance in biology. However, the findings reported that, there is gender equity based on the post test score of the students. This means that the significant difference found among the teaching methods did not depend on students’ gender.

**CONCLUSION**

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

**Recommendation**

From the result of this study, the following recommendations are made:
1. It is evident that, concept mapping and inquiry teaching methods are effective in improving students' achievement in biology. Therefore, teachers should use these teaching methods to facilitate their biology teaching.

2. Symposium and workshops should be organized and made compulsory for practicing teachers so that they can embrace the skills of the teaching methods for effective implementation of the strategies in teaching biology.

3. Pre-service teachers should be exposed to the concept mapping and inquiry teaching methods

4. Concept mapping and inquiry teaching methods should be suggested for some biology content areas in the curriculum.

References


