

EFFECT OF GUIDED INQUIRY ON STUDENT'S ACHIEVEMENT IN BIOLOGY

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Abstract

This paper investigates the effect of guided inquiry and lecture methods on students' academic achievement in biology in senior secondary schools in Rivers State. Two research questions and two null hypotheses tested at 0.05 level of significance guided the study. The sample of the study was 407 SSII biology students drawn by purposive sampling technique in which four schools were selected from eight senior secondary schools in the area of study. The sample consisted of 223 boys and 184 girls. The classes used for the study were selected by simple random sampling using the ballot system. Mean, grand mean, standard deviation and t-test statistic were used to analyze data from the result of Biology Achievement Test used for data collection. The result shows that mean pretest scores of the experimental and control groups used for the study are insignificant. The mean posttest scores show a wide difference. There is a significant difference between the achievements of students taught with guided inquiry and those taught with lecture method in favour of guided inquiry. Guided inquiry proved more effective than lecture method in enhancing students' academic achievement in biology. Recommendations are made from the findings of the study.

Introduction

Biology is a branch of science which deals with the study of living things (Ramalingam, 2000). The subject has opened many careers for students such as in medicine, pharmacy, nursing, veterinary science, food technology, agriculture, etc. Apart from career opportunities from biological studies, the subject has also contributed to the survival of man like in raising desired stocks through cross breeding of various varieties of plants and animal species. Other achievements made through the application of biological techniques for the interest of man include: the development of vaccines and drugs for preventing and curing diseases, invitro fertilization which helps infertile couples to have babies, increased food production, awareness of genetic diseases and their prevention, etc. (Ramalingam, 2000). Biology therefore contributes to national development through its various uses to mankind.

These benefits of biology notwithstanding, students' performance in the subject at SSCE is poor (Nwagbo, 2001; Okoli, 2006; WAEC Chief Examiners report 2002 and 2004). In addition, students find some topics in biology difficult and uninteresting (Nwachukwu & Nwosu, 2006). Topics in biology like respiration, gene, allele, mitosis, ecosystem, mendelian ratio, evolution, etc are perceived difficult by students (Johnson & Mahmoud, 1980; Fakunle, 1983; Okoli, 2006; Ugwuadu & Obi, 2009).

These difficult topics are mostly found in some physiological topics, ecology, genetics and evolution (Ugwuadu & Obi, 2008; Fakunle, 1993; Adeniji, 1983). Many studies have indicated that facilities for science (biology) teaching are inadequate (Olofinboba, 1979, Akinsola & Igwe, 2002; Kafuoru & Memeh, 2007; Nwagbo, 2001). Some of the lacking facilities include: illequipped laboratories, insufficient space, shortage of classrooms, and teaching aids, etc. On teaching methods, research reports reveal that most science teachers use the traditional lecture method in teaching biology. The method does not enhance students' academic achievement especially in the acquisition of process skill. (Gbamanja, 1991; Olariwaju, 1986). In addition, the lecture method is defective because it involves verbal presentation of pre-planned lesson to the students which requires little or no instructional aid and so does not promote students' higher level of thinking (Padron and Waxman, 1991). The teaching method is therefore teacher-centred with reduced student participation since

students remain passive during the lesson. For example, students may not be allowed to ask questions or contribute ideas in a lesson involving the use of lecture method. (Okoli, 2006; Bajah, 1983; Abdullahi, 1982).

Guided inquiry method on the other hand is an approach to teaching in which students are guided by the teacher to find facts for themselves. It is student centered, and activity oriented (Akuma 2005). The method helps to increase the degree of students' interest, confidence, innovativeness, problem – solving ability and consequently improve their performance in both theory and practice (Fatokun & Yalams, 2007). The method also helps students to engage in relatively sophisticated mental processes like formulating problems for investigation, formulating hypotheses, designing experiments, synthesizing knowledge, possessing scientific attitudes etc. (Abdullahi, 1982). The question now is which of the two methods proves superior to the other in enhancing students' academic achievement?

Students' academic achievement refers to students' performance or attainment in a subject. It also means cognitive score (Nwana, 1982; Bajah, 1983; Abdullahi, 1982). According to Nwagbo (2001), achievement in teaching/learning process has to do with attainment of a set of objectives of instruction. If a learner accomplishes a task (for example, a biology problem) successfully and attains the specified goal for a particular learning experience, he is said to have achieved.

The effect of guided inquiry and lecture methods on students' academic achievement in biology will be investigated in this study. The rationale is to establish the method that proves more effective in improving students' achievement in biology. The guided inquiry is innovative in nature, but this is not the question. The question is whether it can enhance students' achievement in biology better than the long existed lecture method that is conventional and commonly used in teaching (Bajah, 1983; Abdullahi, 1982).

However, a lot of research reports indicated that the guided inquiry method enhanced students' achievement in science lessons, biology inclusive (Fatokun & Yalams, 2007; Nworgu, 1985; Nwagbo, 2001; Akuma, 2007, Okoli, 2006). This situation is worthy of re-investigation especially in the area of this study where none of the studies took place. The problem of this study is therefore to determine which of the two methods (guided inquiry and lecture method) is more effective in enhancing students' academic achievement in biology by using a biology topic respiration in carrying out the study. This is because respiration is among the biology topics perceived difficult by students, (Ugwuaddu & Obi, 2009 so differences in performances can easily be observed after the study.

Purpose of the Study: The main purpose of this study is to investigate the effect of guided inquiry and lecture methods on students' academic achievement in biology. The specific objective is to determine the effect of guided inquiry and lecture methods on students' academic achievement in biology.

Research Questions: The following research questions guided the study.

1. What is the mean pre-test scores of experimental and control groups used for the study?
2. What is the mean post test scores of students taught with guided inquiry method and those taught with lecture method?

Hypotheses: The following null hypotheses tested at 0.05 level of significance guided the study.

HO₁: There is no significant difference between the mean pretest scores of experimental and control groups used for the study.

HO₂: There is no significant difference between the mean achievement scores of students taught with guided inquiry method and those taught with lecture method.

Methodology

Research Design: The research design of this study was the quasi-experimental design of pretest-posttest, non-equivalent non-randomized control design. This design was used because intact classes

were used so that school activities would not be disturbed. The design was also used because it involved randomization of classes and not individual students.

Area of Study: This study was carried out in Yola North local Government Area of Adamawa State.

Population of the Study: The population of this study consisted of all secondary school (SSII) biology students in the eight State-owned senior secondary schools in Yola-North Local Government Area of Adamawa State. The eight secondary schools present students for SSCE. All the schools are co-educational except two of them that are unisex (boys or girls school). The population of the students was 1460 made up of 820 boys and 640 girls as at 2007/2008 session. All the schools have four streams of SSII.

Sample and Sampling Technique: The researcher used the purposive sampling technique to draw samples from the secondary schools used for the study so that the two unisex schools would be included in the study. Four schools were selected: namely two unisex schools (boys or girls) and two co-educational schools. Two streams out of four streams each of SSII in each school were selected from the four schools by ballot system for the study. In the single-sex school (boys) the sample size was 112 students in the two streams. In the single-sex school (girls) the sample size was 102 in the two streams. In one co-educational school, the sample size of girls was 40 and boys 60, while in the other co-educational school boys were 51 and girls 42. The total sample size used for the study was 223 boys and 184 girls. The total sample for study was divided into two groups: Group A experimental group taught with guided inquiry method and group B control group, taught with lecture method. This was arrived at by ballot system: The experimental group consisted of 112 boys and 92 girls while control consisted of 111 boys and 92 girls.

Instrument of the Study: Two instruments constructed by the researcher were used to collect data for this study. The instruments were: the Biology Achievement Test (BAT) and lesson plan prepared on a biology topic – respiration. BAT contained 40 multiple – choice objective test on respiration.

Validation of the Instrument: Two experts in Science Education (Biology) from Department of Science Education, Federal University of Technology, Yola validated the instruments (BAT) and the lesson plan and made amendments where necessary in terms of content coverage of items and use of expressions to avoid ambiguity. After making corrections from the validators, the instruments were found to have both content and face validity and were used for the study.

Reliability of the Instrument: The cronbach alfa method was used to calculate the reliability coefficient of BAT to estimate the internal consistency. Data from pilot study with three schools outside the ones used for the study were used to calculate the reliability coefficient. The reliability coefficient of BAT was 0.82.

Method of Data Collection: Pretest was administered on the experimental and control groups using the Biology Achievement Test. The scores were obtained and recorded for each of the two groups.

Treatment: The experimental group was taught in each school with guided inquiry method using the lesson plan. The researcher trained the classroom teachers in each school who helped him in the data collection exercise in teaching the students, marking and recording of scores. The control group was taught with lecture method using the prepared lesson plan with the assistance of the trained classroom teachers too. The experiment was coordinated and supervised by the researcher. After teaching, posttest was administered with the same BAT on the two groups (experimental and control). The scores were obtained and recorded for each group and used for data analysis.

Method of Data Analysis: Data collected for BAT were analyzed using mean, grand mean, standard deviation and t-test statistic. For hypothesis testing, t-test statistic was used and the decision rule was that if t-calculated was less than the critical value (table value) at 0.05 level of significance, the null hypothesis was accepted ($P < 0.05$) but if the t-calculated was greater than the critical value at 0.05 level of significance, the null hypothesis was rejected ($P > 0.05$).

Result: Research question I: What is the mean pretest scores of experimental and control groups used for the study?

Table 1: Mean Pretest result of Experimental and Control Groups

Groups	n	\bar{x}	SD
Experimental group (boys)	112	27.10	0.86
Experimental group (girls)	92	27.06	0.83
Control group (boys)	111	27.02	0.82
Control group (girls)	92	27.08	0.78

The result in Table 1 shows the mean pretest scores of experimental and control groups. It can be observed that the two groups performed relatively equally. The mean difference in their pretest scores was small (0.06) meaning that the two groups were of equal academic background by this result.

HO₁: There is no significant difference between the mean pretest scores of experimental and control groups used for the study.

Table 2: T-Test Analysis of Mean Pretest Scores of Experimental and Control Groups

Groups	G \bar{x}	SD	N	DF	Standard error	t-cal.	t-crit.
Experimental group (boys and girls together)	27.08	0.85	204	405	0.082	0.375*	1.96
Control group (boys and girls together)	27.05	0.80	203				

$G\bar{x}$ = Grand mean. * Not significant at 0.05 level of significance.

Table 2 shows the t-test comparison of the mean pretest scores of the experimental and control groups. The t-calculated is less than t-critical at 0.05 level of significance. The null hypothesis (HO₁) is accepted. This result confirms that the experimental group and control groups have equal academic background.

Research Question 2: What is the mean post test scores of students taught with guided inquiry method and those taught with lecture method?

Table 3: Post-Test Result of Students Taught With Guided Inquiry Method and Those Taught With Lecture Method

Groups	N	\bar{x}	SD
Students taught with guided inquiry method (experimental groups)	204	37.19	1.01
Students taught with lecture method (control groups)	203	27.60	0.88

Table 3 shows the mean post test scores of students taught with guided and lecture methods. There was a marked wide mean difference between the two groups (9.59). Since the pretest score was relatively equal with a very small difference it can be deduced that this wide mean post test difference was due to treatment effect.

HO₂: There is no significant difference between the mean achievement scores of students taught with guided inquiry method and those taught with lecture method.

Table 4: T-Test Analysis of Mean Post Test Scores of Student Taught With Guided Inquiry and Those Taught With Lecture Method

Groups	Gx	SD	N	DF	Standard error	t-cal.	t-crit.
Students taught with guided inquiry method	37.19	1.01	204	405	0.009	106.55*	1.96
Students taught with lecture method	27.60	0.88	203				

*Significant at 0.05 level of significance

Table 4 shows that the t-calculated is greater than the t-critical at 0.05 level of significance, so HO₂ is rejected because there is significant difference between them. The significant difference is in favour of guided inquiry method implying that the students taught with the method performed better than those taught with lecture method.

Findings from the Study: The following findings resulted from this study;

- (1) The difference in the mean pretest scores of experimental and control groups used for the study was small meaning that the two groups are equivalent and do not differ much in their academic background knowledge. When the pretest mean scores were compared using the t-test statistic there was no significant difference ($P < 0.05$) in their performance; so HO₁ is accepted. (Tables 1 & 2)
- (2) The posttest achievement scores of experimental group (groups taught with guided inquiry method) and control (those taught with lecture) showed wide difference of (9.59). Experimental group had a mean score of 37.19 while the control group had 27.60 mean score (Table 3).
- (3) There was significant difference between the performance of students taught with guided inquiry method and those taught with lecture method. The null hypothesis (HO₂) is rejected ($P > 0.05$) (Table 4). The significant difference is in favour of guided inquiry method.
- (4) The guided inquiry method has positive effect on students' academic achievement because it produced treatment effect of higher performance than lecture method on the students used for the study.

Discussion

The results on (Tables 1-4) indicate that students taught with guided inquiry method performed better than those taught with conventional lecture method. Since the pretest result did not produce any appreciable difference in performance, it all means that the significant difference in performance was caused by treatment effect. The effect of guided inquiry in producing higher academic achievement in students is inline with the findings of Usman & Memeh; 2007; Fatokun & Yalams, 2007; Nworgu, 1985; Nwagbo, 2001; Akuma, 2005; and Okoli, 2006). These researchers found out that guided inquiry was more effective than the lecture method in enhancing students' achievement. This study therefore confirmed the positive effect of using guided inquiry method as found in these previous studies. It means that the method can be used to teach students in order to reduce poor academic performance in biology. Biology has been recording poor performance among students in SSCE over the years and one reason was the constant use of lecture method in teaching the subject (Nwagbo, 2001; Okoli, 2006; Nwachuku & Nwosu, 2007). In addition WAEC Chief Examiner's report (2002 & 2004) indicated that the major reason causing poor performance in biology was students' poor achievement in biology practical. The guided inquiry is relevant in teaching biology practical because it is teacher-guided and demands the use of much of science process skills in doing it to record good results (Openg 1981; Njoku, 2002). The researchers suggested the use of guided inquiry in teaching science practicals. There is every reason for biology teachers to exploit this important method (guided inquiry) in teaching biology so that students' poor performance can be improved.

Literature has also revealed that students perceive some biology topics difficult (Johnson & Mahmoud, 1980; Okoli, 2002; Nwachukwu and Nwosu, 2001). It is again through teacher-guided instructions that such a problem can be solved. The reason is that teacher-guided inquiry is student-centred because students participate actively in so many ways in the lesson in which it is used. During teacher-guided instruction, students ask questions, contribute ideas, formulate problems for investigation, formulate hypothesis, design experiments, etc as opined by Abdullahi (1982), and Bajah (1983). These activities show how scientists work so guided-inquiry method is result-oriented. When used effectively, the difficult topics in biology like: ecology, genetics, some physiological biology like topics, respiration etc, are likely to be solved especially in areas of difficulty and abstraction. This is because the students are under the guidance of the teacher who will explain, demonstrate and reinforce their efforts in biology classrooms. One constraint in using this innovative and effective method is inadequate infrastructural facilities in our schools as revealed by Nwagbo, 2001; Olofinboba, 1979; and Okoli, 2006. Although this is a drawback, teachers should not be discouraged, but maximize their efforts through improvisation, creativity and resourcefulness so that the use of guided inquiry in Biology teaching suffers or no impediments.

Recommendations

The following recommendations are made from the findings of this study;

1. Guided inquiry method should be practised seriously by biology teachers since the method has proved effective in enhancing students' academic achievement in biology.
2. Biology teachers should reduce if not eliminate the use of Lecture method in biology teaching because, it is defective. The method does not enhance students' academic achievement in biology as revealed by the result of this study.
3. Government should provide enough facilities for biology teaching because guided inquiry method is activity-oriented and so demands the use of enough instructional materials.
4. Teachers should be patient in using the guided inquiry method because it is time and energy-consuming for it to be result – oriented.
5. Enough funds should be provided to schools by stakeholders in education for guided inquiry method to be feasible because it is expensive to use.

Conclusion

Guided inquiry method contradicts sharply with lecture method because it enhances students' academic achievement in biology going by the result of this study. The method is practical-oriented, student-centered and enables students to be actively engaged in a lesson. Some difficulties encountered in biology teaching like poor performance, topic difficulty can be reduced using the guided inquiry method which is teacher-guided and effective. The method can stimulate students' interest to learn due to activity-oriented nature of the method. There is every reason to encourage teachers to use the guided inquiry method in biology teaching because the method has proved effective by the result of this study.

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