



Effect of Inquiry-Based Instruction on Students' Achievement and Retention in Biology in Hadejia Education Zone, Jigawa State

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ABSTRACT

This study evaluated the effect of inquiry-based instruction on students' achievement and retention in Biology in Hadejia Education Zone, Jigawa State, Nigeria. The study was quasi-experimental, pretest-posttest control group design. The sample was drawn from intact classes from four single educational schools. A total of 184 male and female students were used in the study. The sample were got using purposive and simple random sampling techniques. The instrument for the study was designed by the researchers and tagged Biology Achievement Test (BAT). This was validated by experts and Kuder- Richardson 20 formulae was used to estimate the reliability which yielded a coefficient of 0.82 alpha. Mean and standard deviation was used to answer the all the research questions while ANCOVA was used to test the four hypotheses at 0.05 significant level. Results showed that students taught biology via IBI instructional approach significantly gained higher mean achievement scores and retention scores than their counterparts in the control group ($p=0.00$ for both cases). The study also found that male and female students' achievement ($p=0.35$) and retention ($p=0.20$) did not significantly differed. Based on these, the study recommended that teachers of biology should adopt this approach in teaching their students for better achievement and dissipate boredom from their classrooms.

Keyword: Inquiry-Based Instructional Approach, Achievement, Retention, Gender

Introduction

Education is an instrument used in developing citizens who in turn contribute to national development. The educational development of any country is therefore given paramount attention in order to secure the future of the nation. One area of education that has remained outstanding in national development is science. Science has been instrumental in shaping and improving the destiny of humanity (Ezeudu, Ofoegbu, & Anyaegbunnam, 2013). Science gives explanations to things and raises human beings above animals (Abubakar, 2015). Science in secondary schools is taught through the separate science subjects as Chemistry, Physics and Biology. The importance of these science subjects, particularly Biology cannot be overemphasis.

Biology as the science of life is offered in all Senior Secondary Schools in Nigeria and attracts the patronage of both Science oriented and Arts based students (Nwosu, 2006). Urevbu (1990) points out that the teaching of Biology is important because it equips the



students to comprehend the world around them and equip them with the necessary skills to build a progressive society. Similarly, Nwosu (2006) observed that Biology provides a platform for teaching students to develop the ability to apply science concepts and principles in solving everyday life problems. Recent advancement recorded in Biology related fields such as Biochemistry, Physiology, Ecology, Genetics and Molecular Biology made the subject a central focus in most human activities including solving problems like food scarcity, pollution, population, radiation, disease, health, hygiene, family life, management and conservation of natural resources. It is therefore expected that students' achievement in Biology should be impressive to indicate that the goals of teaching Biology are attained. Nevertheless, students' performance in the subject remains a worrisome issue.

Abubakar (2015) reported that the rate at which students in public schools in Jigawa State are getting poor results in Biology despite the huge amount of money the government was said to have expended on education is causing concern. Commenting on students' achievement in Biology, Okafor and Okeke (2006) observed that students' performance in the subject is generally poor in Senior Secondary School Certificate (SSCE). This problem of poor performances in sciences is generally attributed to the fact that despite the much acclaimed modern teaching approaches abound, the traditional teaching approaches are still prevailing in most schools (Imoko & Jimin, 2016). The traditional approaches are therefore failing to make students to understand and retain knowledge to write external examinations that are not immediate. Similarly, Omajuwa (2011) attributes the students' poor performances to poor teaching techniques used by teachers in the Senior Secondary Schools.

The reported constant poor performance in SSCE Biology has attracted a lot of concern from science educators. Thus, researchers in science education in Nigeria has continued to seek better ways of teaching Biology in order to maximize meaningful learning (Esiobu, 2000). One strategy that has recorded success among researchers report is Inquiry-Based Instructional (IBI). Inquiry-based instruction is used here as a broad umbrella term to describe approaches to learning that are driven by a process of inquiry.

The instructional approach is a research-based strategy that actively involves students in the exploration of the content, issues, and questions surrounding a curricular area or concept. Activities in an inquiry-based classroom are designed to make students work individually or in group to solve problems involving both in-class work and fieldwork. The approach is highly student-focused with the teacher's role limited to facilitation. The teacher acts as a facilitator with the extent of involvement varying and depending on the level of the students understanding of the inquiry process. Opera and Oguzor (2011) averred that the teachers' role in inquiry-based class is that of establishing the task and supporting the process, while students pursue their own lines of inquiry, draw on their existing knowledge and identify the consequent learning needs. The approach stimulates students to follow up interesting lines of inquiry and supports them in concentrating their efforts where they need to undertake further work (Khan & O'Rourke, 2012). Gormally, Brickman, Hallar and Armstrong (2009) submitted that inquiry-based learning is capable of improving students' science literacy skills abilities and self-confidence. It is with this background in mind that the



researcher set up this work to investigate the effect of inquiry-based instructional strategy on students' achievement and retention in Biology.

Research Questions

Four research questions were raised and answered in this study.

1. What is the mean performance scores of students taught Biology using inquiry-based instruction and those who were taught using a traditional approach?
2. What are the mean retention scores of students taught Biology using inquiry-based instruction and those who were taught using a traditional approach?
3. What are the mean performance scores of male and female students exposed to inquiry-based instruction?
4. What are the mean retention scores of male and female students exposed to inquiry-based instruction?

Null Hypotheses

The following null hypotheses were tested in the study at 0.05 significant level.

1. There is no significant difference in the mean performance scores of students taught Biology using inquiry-based instruction and those who were taught via traditional approach.
2. There is no significant difference in the mean retention scores of students taught Biology using inquiry-based instruction and those who were taught using traditional approach.
3. There is no significant difference in the mean performance scores of male and female students taught biology using inquiry-based instruction.
4. There is no significant difference in the mean retention scores of male and female students taught biology using inquiry-based instruction.

Methodology

The study was conducted using a quasi-experimental, pre test-post test control group design. The choice of this design over others was due to the fact that the researcher used students' intact classes due to the inability to randomize students into the experimental and controlled conditions. The area of study was Hadejia Education Zone, Jigawa State which comprise of 3 Local Government Areas. The population of the study consisted of 2050 Senior Secondary 2 (SS2) students from the study area. The sample consisted of 184 students drawn from 4 intact classes through purposive and simple random sampling techniques. One school was randomly selected from each of the Local Government while the last was randomly picked among the three Local Government Areas. Out of the four schools selected, two were randomly assigned to the experimental conditions and were taught using inquiry-based instruction while the other two were taught using their teachers preferred methods.

An instrument designed by the researcher and named Biology Achievement Test was used to collect to measure students' achievement and retention. The instrument was a 40-item multi-choice test with options A-D. The reliability of the instrument was computed using Kuder-Richardson $_{20}$ ($K-R_{20}$) and found to be 0.82. The test was given to the students as a



pre-test to ascertain the entry knowledge of students and reshuffled to be used as post-test and retention test. A teacher's guide on the implementation of inquiry-based instruction was designed by the researcher for the experimental group while the control group teachers taught

with their prepared lesson notes. Teachers from both groups were given four weeks to teach topics specified by the researcher after the pre-test. The post-test was immediately administered after the teaching while the retention test was given to the students after four months. Means and Standard Deviations were used to answer the 4 research questions while the 4 hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

Research Question 1

What are the mean performance scores of students taught Biology using inquiry-based instruction and those who were taught using a traditional approach?

Table 1: Mean performance scores and standard deviations of students in experimental and control groups

Group	N	Pre Test Scores		Post Test Scores		Mean Gain
		\bar{x}	δ	\bar{x}	δ	
Experimental	105	10.13	4.29	25.83	5.92	15.70
Control	79	9.65	3.96	18.54	6.29	8.89
Mean Difference		0.48		7.29		6.81

Table 1 presents mean performance scores and standard deviations of students in experimental and control groups. The mean performance score of students in the experimental group at pre-test was 10.13 ± 4.29 while that of control group was 9.65 ± 3.96 . The table reveals the means at post-test as 25.83 ± 5.92 for experimental group and 18.54 ± 6.29 for control group. The difference between the pre-test means was shown as 0.48 while that of post-test was revealed as 7.29. The mean gained by the experimental and control groups were 15.70 and 8.89 respectively. The difference in the mean gains between the groups was 6.81. This suggests that students in the experimental group gained more mean performance score than those in the control group.

Research Question 2

What are the mean retention scores of students taught Biology using inquiry-based instruction and those who were taught using a traditional approach?

Table 2: Mean retention scores and standard deviations of students in experimental and control groups

Group	N	Pre Test Scores		Retention Test Scores		Mean Gain
		\bar{x}	δ	\bar{x}	δ	
Experimental	105	10.13	4.29	22.77	5.36	12.64

Control	79	9.65	3.96	15.39	5.65	5.74
Mean Difference		0.48		7.38		6.90

Table 2 presents mean retention scores and standard deviations of students in experimental and control groups. The mean retention score of students in the experimental group was

shown as 22.77 ± 5.36 while that of control group was 15.39 ± 5.65 . The difference between the retention means was shown as 7.38. The mean retention gained by the experimental and control groups were 12.64 and 5.74 respectively. The difference in the mean gains was 6.90 which suggest that students in the experimental group retained knowledge more than those in the control group.

Research Question 3

What are the mean performance scores of male and female students exposed to inquiry-based instruction?

Table 3: Mean performance scores and standard deviations of male and female students in experimental group

Gender	N	Pre Test Scores		Post Test Scores		Mean Gain
		\bar{x}	δ	\bar{x}	δ	
Male Students	62	10.35	4.67	26.37	5.67	16.02
Female Students	43	9.81	3.72	25.05	6.25	15.24
Mean Difference		0.54		1.32		0.78

Table 3 presents mean performance scores and standard deviations of students in experimental group according to gender. The mean performance score of male students at pre-test was 10.35 ± 4.67 and that of female students was 9.81 ± 3.72 . Result from Table 3 reveals the means at post-test for male and female students as 26.37 ± 5.67 and 25.05 ± 6.25 respectively. The differences between the means at pre-test and post-test were revealed as 0.54 and 1.32. The mean gained by male students was 16.02 while female students gained 15.24. The difference in the mean gains was 0.78 which suggests the difference between gender performance was small.

Research Question 4

What are the mean retention scores of male and female students exposed to inquiry-based instruction?

Table 4: Mean retention scores and standard deviations of male and female students in experimental group

Gender	N	Pre Test Scores		Post Test Scores		Mean Gain
		\bar{x}	δ	\bar{x}	δ	



Male Students	62	10.35	4.29	23.40	5.31	13.05
Female Students	43	9.81	3.96	21.86	5.37	12.21
Mean Difference		0.54		1.54		0.84

Table 4 presents mean retention scores and standard deviations of students in experimental group according to gender. The mean retention score of male was shown as 23.40 ± 5.31 while female students retained 21.86 ± 5.37 . The difference between the retention means gains were

shown as 13.05 for male and 12.21 for female. The difference in the mean gains was 0.84. This indicates that the difference between gender mean retention gains was small.

Null Hypothesis 1

There is no significant difference in the mean achievement scores of students taught Biology using inquiry-based instruction and those who were taught via traditional approach.

Table 5: One-way ANCOVA report on the effect of inquiry-based instruction on students' achievement in biology

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5106.75	2	2553.37	114.97	0.00
Intercept	4604.59	1	4604.9	207.33	0.00
pretest	2714.69	1	2714.69	122.23	0.00
group	2096.40	1	2096.40	94.39	0.00
Error	4019.81	181	22.21		
Total	103949.00	184			
Corrected Total	9126.56	183			

Table 5 presents one-way ANCOVA report on the effect of Inquiry-Based Instruction (IBL) on students' performance in biology. The table reveals that $F_{(1,181)} = 94.39$ and $p = 0.00$. With $p < 0.05$, (p is the significant value and 0.05 the level of significance for the study), the study find the test statistic significant. The null hypothesis which states that there is no significant difference in the mean performance scores of students taught biology using IBI and those who were not taught using a traditional approach was rejected. This indicates that, the students taught with IBI attained higher mean score at post-test compared to their counterparts in the control group.

Null Hypothesis 2

There is no significant difference in the mean retention scores of students taught Biology using inquiry-based instruction and those who were taught using traditional approach.

Table 6: One-way ANCOVA report on the effect of inquiry-based instruction on students' retention in biology



Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4300.32	2	2150.16	107.10	0.00
Intercept	3608.10	1	3608.10	179.72	0.00
pretest	1845.63	1	1845.63	91.93	0.00
group	2204.75	1	2204.75	109.82	0.00
Error	3633.72	181	20.08		
Total	78643.00	184			
Corrected Total	7934.04	183			

Table 6 presents one-way ANCOVA report on the effect of inquiry-based instruction on students' retention in biology. The table reveals that $F_{(1,181)} = 109.82$ and $p = 0.00$. Since $p < 0.05$, the study find the test statistic significant. The null hypothesis which states that there is no significant difference in the mean retention scores of students taught biology using IBI and those who were not taught using a traditional approach was rejected. This indicates that, the students taught with IBI obtained higher mean score at retention-test compared to their counterparts in the control group.

Null Hypothesis 3

There is no significant difference in the mean achievement scores of male and female students taught biology using inquiry-based instruction.

Table 7: One-way ANCOVA report on the effect of inquiry-based instruction on students' achievement in biology according to gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	927.96	2	463.98	17.41	0.00
Intercept	5634.80	1	5634.80	211.39	0.00
pretest	883.42	1	883.42	33.14	0.00
gender	23.15	1	23.15	0.87	0.35
Error	2718.96	102	26.66		
Total	73694.00	105			
Corrected Total	3646.91	104			

Table 7 presents one-way ANCOVA report on the effect of IBL on students' achievement in biology according to gender. The table reveals that $F_{(1,102)} = 0.87$ and $p = 0.35$. With $p > 0.05$, the study find the test statistic not to be significant. The null hypothesis which states that there is no significant difference in the mean achievement scores of male and female students taught biology using IBI was not rejected. This indicates that, IBI is not gender sensitive in terms of students' achievement.

Null Hypothesis 4

There is no significant difference in the mean retention scores of male and female students taught biology using inquiry-based instruction.



Table 8: One-way ANCOVA report on the effect of inquiry-based instruction on students' retention in biology according to gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	700.65	2	350.32	15.59	0.00
Intercept	4472.09	1	4472.09	199.03	0.00
pretest	640.22	1	640.22	28.49	0.00
gender	38.24	1	38.24	1.70	0.20
Error	2291.87	102	22.47		
Total	57439.00	105			
Corrected Total	2992.51	104			

Table 8 presents one-way ANCOVA report on the effect of inquiry based instruction on students' retention in biology according to gender. The table reveals that $F_{(1,102)} = 1.70$ and $p = 0.20$. With $p > 0.05$, the study find the test statistic not to be significant. The null hypothesis which states that there is no significant difference in the mean retention scores of male and female students taught biology using IBI was not rejected. The conclusion was that, with IBI, the retention ability of male and female students did not significantly differed achievement.

Discussion of the Findings

This study investigated the effect of inquiry-based instructional strategy on students' retention in biology in Hadejia Education Zone. Results from analysis in Tables 1 and 5 indicates that students taught biology using IBI significantly obtained higher mean achievement scores in BAT compared to those who were not taught using a traditional approach. The study also found in Table 2 and 6 that students taught biology using IBI significantly obtained higher mean retention score in the retention test compared to those who were not taught using a traditional approach. This finding was attributed to the fact that students who were taught biology using IBI were more involved in the learning process which enhanced their understanding and made learning more permanent.

This finding is in conformity with the funding of Imoko and Jimin (2016) which stated that IBI was instrumental to students, achievement in geometric constructions. This study is also in agreement with the findings of Gormally, Brickman, Hallar and Armstrong (2009) that inquiry-based learning significantly improved students' science literacy skills abilities and self-confidence compared to students taught using traditional method.

This finding is also in consonance with the findings of Akkus, Gunel, and Hand (2007) that inquiry method has significant effect on students' learning outcomes when compared to other traditional methods. The result was consistent with the finding of Remziye, Yeter, Sevgul, Zehra and Meral (2011) who found in a study on effects of Inquiry-based Science teaching on elementary school students' science process skills and science attitude that inquiry-based teaching significantly enhances students' science process skills and attitude. The study also found in Table 3, 4, 7 and 8 that the mean achievement scores and mean retention scores of male and female students taught biology using IBI did not significantly differ. This was an indication that IBI was no gender sensitive. This finding is in agreement with the findings of Agboghoroma and Oyovwi (2015) which stated that there was



no significant difference between the performance of male and female students when exposed to difficult topics in biology. The findings of this study is in agreement with those of Akpokorie (2000) and Omajuwa (2011) who submitted that sex have no influence on students achievement in biology when taught IBI methods.

Recommendations

Based on the findings of this study the following recommendations are made:

1. Since it has been observed that those taught biology using IBI instructional approach performed better than their control group counterparts, it is recommended that teachers of biology should adopt this approach in teaching their students for better achievement and dissipate boredom from their classrooms. The students would be kept very busy since they enjoy activities.
2. With the performances of male and female students not seen to be significantly different, biology teachers should feel free to use IBI instructional approach in teaching but male and female students.

Conclusion

The purpose of this study was to determine the effects of inquiry-based instructional approach on students' achievement and retention in biology. The results indicated that IBI instructional approach could have a positive effect on students' achievement and retention in biology. This research has demonstrated that with proper instructional activities, IBI instructional approach might be a valuable tool not only to enhancing students' immediate achievement in biology, but also their retention in the long run.

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