Enhancing Male and Female Secondary School Students' Achievement in Basic Science Using Inquiry - Based Teaching Strategy

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Abstract: This study was designed to investigate the effect of inquiry - based teaching strategy on the academic achievement of junior secondary school students in Basic Science. The study was a quasi experimental pre – test, post test, non equivalent control group design involving intact classes without randomization. The study was guided by two research questions and two hypotheses. A sample of three hundred and fourteen (314) junior secondary school two (JSS ll) was drawn using purposive sampling technique from four co-educational secondary schools in Nsukka Education Zone. Intact classes were randomly assigned experimental and control groups. Students in all classes were pre – tested before the instruction and post - tested after instruction. Basic Science Achievement Test (BSAT) was used for data collection. The instrument was validated by three research experts and a reliability co – efficient of .78 obtained using Kuder Richardson 20 (KR - 20) formular. Data obtained were analyzed using mean and standard deviation to answer research questions, while analysis of covariance (ANCOVA) tested at 0.05 level of significance was used for testing the hypotheses. The results obtained revealed that the female achieved slightly higher than the male counter parts in the past achievement test. Further investigation with the ANCOVA revealed that there is no significant difference in the achievement of male and female students in their mean achievement score. On the other hand, there is a significant interaction effect of treatment and gender on students' mean scores in the post achievement test. Therefore, this study suggests that innovative strategies like inquiry – based teaching should be employed in the teaching and learning of science subjects.

Keywords: Academic achievement, Covariance, Enhancement, innovative strategies, Randomization, Teaching, Science subjects

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1. INTRODUCTION

Science is very crucial in shaping the way we think, explore, generate and apply knowledge about our environment. The dominant role played by science and technology facilitate most nations' development. The development of a nation depends largely on the level of its scientific and technological literacy. This is the reason why every Country craves for advancement in science and technology.

The unique nature of the Basic Science Curriculum is such that broad structure encompasses not only the traditional science fields but also some contemporary issues such as entrepreneurship education, reproductive health education, environmental and social education. These bits of scientific skills and knowledge will enable the Nigerian child face life challenges, and live functionally in the global community. The desire for improvement in the teaching of science has been increased by the awareness of the contribution of science and technology to meaningful economic, social and political development.

Inspite of the tremendous importance of Basic Science to personal and national development, there is still enough evidence that students still perform poorly in the subject. The worrisome deteriorating state of students' poor achievement in Secondary School Basic Science deserves the interest of educators and researchers alike. It has been empirically evidenced that students' scientific literacy levels are low and that students find it difficult to master the science concepts and principles available in the science curriculum [1], [2], [3]. Many science educators present this poor performance in science and its effect on technological advancement of the Country as their major concern and worry. Evidently, research results have continued to implicate teaching methods as a major factor causing this ugly menace. The need to foster students' achievement in Basic Science has given rise to innovative approaches that provide room for students' active participation in the lesson. Inquiry – based learning strategy seems to be a promising approach for a number of reasons.

Inquiry – based learning encompasses an instructional model and strategies that focus on active, hands – on learning opportunities for students [4]. [5] describe a major attribute of inquiry learning as exploring and problem solving. Through exploring and problem solving, students take on an active role to create, integrate and generalize knowledge. Instead of engaging in passively accepting information through lecture or drill and practice, students establish broader applications for skills through activities that encourage risk – taking, problem solving, and an examination of unique experiences [5]. Here, the students rather than the teacher drive the learning.

Inquiry – based learning encourages students to learn at their own pace [6]. Through this method of teaching, some degrees of flexibility in sequencing and frequenting with learning activities can be achieved. Learning is not a static progression of lessons and activities. Inquiry learning contributes greatly to students' motivation and ownership of their learning.

Inquiry – based learning depends on the principle of using existing knowledge as a basis to build new knowledge [5]. Scenarios with which the students are familiar allow the students to build on their existing knowledge by extending what they already know to invent new ideas. Also, there is opportunity for feedback in the learning process. Student learning is enhanced, deepened, and made more permanent by discussion of the topic with other learners. Without the opportunity for feedback, learning is left incomplete. Instead of students' learning in isolation as is typical in the traditional classroom using expository learning method where silence is expected, students are encouraged to discuss their ideas to deepen their understanding.

Inquiry – based strategy is an example of constructivist learning strategy which poses significant contextualized real world situations and provides resources, guidance and instruction to learners as they develop content, knowledge and problem solving skills [7].Constructivist theory is the basis for inquiry - based learning. Under both constructivism and inquiry learning, educators subscribe to the idea that knowledge cannot be transferred from one person to another [8].

Instead, a student needs to experience an event in order to make it truly meaningful. In a constructivist classroom, the role of the teacher is less defined. The teacher is no longer the focal point of the class instead, the supposed constructor is now seen as a "facilitator, mentor, coach, or consultant" [9]. Additionally, the role and expectations of the students are transformed.

Under constructivist theory, the emphasis is not on the amount of contents that a student manages to retain, but is on the manner in which the student learn, or construct knowledge [9]. Consequently, inquiry – based strategy imply that learners construct their idea about the world and this helps them experience an event and make it meaningful.

Inquiry – based strategy has been found to be beneficial to students by giving them the opportunities to develop and use social and inquiry skills which enable them to participate as responsible members of the team. The inquiry – based strategy has been found to be efficacious in fostering students' achievement in some school subjects, but there is paucity of research evidence on its impact in Basis Science teaching in Nigerian Secondary School

In the past years, many scholars, researchers and educators have diverse opinions about influence of gender on students' achievement in science subjects. Some studies revealed that males achieve better than females in science [10], [11], [12] observed that female students achieve better than the male students in science. They observed that sex has significant effect in favour of females in cognitive achievement. This shows that there is a controversy on science achievement by gender. This underscores the need to investigate the effect of gender on students' achievement in Basic Science using inquiry – based teaching strategy.

Therefore, this study aimed at investigating the effect of inquiry - based teaching, strategy on male and female secondary school students' achievement in Basic Science.

 Specifically, the study sought to:

(1) Determine the mean achievement scores of male and female students in Basic Science Achievement Test when taught the unit of reproduction with inquiry – based strategy.

 (2) Determine the mean achievement scores of male and female students in Basic Science Achievement Test (BSAT) when taught the unit of ''reproduction'' with expository method.

The aforementioned were achieved using the following research questions

1.2 Research Questions:

1.   What are the mean achievement scores of male and female students in Basic Science Achievement Test when taught selected basic science topics with inquiry – based strategy?

2.   What are the mean achievement scores of male and female students in Basic Science Achievement Test (BSAT) when taught selected basic Science topics with expository strategy?

1.3 Hypotheses

The following null hypotheses were tested at 5 %level of significance

Ho_1: There is no significant difference between the mean achievement scores of male and female students in Basic Science Achievement Test (BSAT) using inquiry - based strategy.

Ho_2: There is no significant interaction effect between instructional strategies and genders on students' mean achievement scores in Basic Science Achievement Test (BSAT)

2. METHODOLOGY

2.1 Research Design

The study adopted a quasi – experimental pre – test, post test, non equivalent control group design involving intact classes without randomization.

The areas covered in this study were three local government areas in Nsukka Education Zone. The population for the study consisted of all the Junior Secondary School Two (JSS ll) students in the thirty – six (36) junior secondary schools in the three Local Government Areas in Nsukka Education Zone of Enugu State; numbering twelve thousand, three hundred and fifty-five (12,355) students as at the time of this study

A sample of three hundred and fourteen (314) junior secondary school two (JSS ll) students was used in the study. The sample was made up of three hundred and fourteen (314) Basic Science students, (155 students in inquiry – based teaching strategy group and 159 students in the expository strategy group) drawn using purposive sampling techniques from the co – educational secondary schools in the Zone. Four schools were sampled each with two or more JSS ll classes. Two intact classes were sampled in each school.

From the two intact classes, one was randomly assigned to inquiry - based instruction while the other was assigned to expository teaching method. The total number of male students in the treatment group was 71 while the female was 84, whereas in the control, there were 73 male students and 86 female students. These gave a total of 144 males and 170 females.

The instrument used for data collection was the Basic Science Achievement Test (BSAT). BSTAT was developed by the researcher. It was made up of thirty (30) multiple choice questions with four options each. The items were draw using a table of specification to ensure adequate coverage of the content area used in the study as well as maintain even spread across the different levels of cognitive domain tested. The instrument was face validated by three research experts. Since the items of the BSTAT were dichotomously scored, Kuder – Richardson's Formula 20 (KR - 20) was used to determine the reliability. The instrument was administered to JSS ll Students in a different school outside the ones used for the study. The scores obtained were used to get the reliability co-efficient of .78 for the instrument.

2.2 Experimental Procedures

Four regular Basic Science teachers in the four secondary schools used in the study were trained by the researcher as research assistants for a period of two weeks on the use of the inquiry – based teaching strategy [IBTS] used in the study. The research subjects were given the pre-test before the commencement of the treatment. Thereafter, the treatment was administered for a period of six weeks. The experimental group in each school was taught the four sub- units of reproduction using the IBTS while the control groups in each school were taught the same topics using expository strategy.

After the treatment, the post-BSAT was administered to the subjects in both groups. Pre-test and Post-test scripts were marked and scores recorded.

Research questions were answered using mean statistics and standard deviation while the hypotheses were tested using analysis of covariance (ANCOVA) at 5% level of significance.

3. RESULT

In answering the research questions, stated as:

Research Question 1

What are the mean achievement score of male and female students in Basic Science Achievement Test using inquiry - based strategy? Using table 1 as shown below;

Table 1 Mean achievement score of male and female students in the experimental group

	Male	(n – 71)	Female	(n – 84)
	$\bar{x}$	SD	$\bar{x}$	SD
Post test	19.01	1.84	19.06	2.79
Pretest	13.74	3.68	13.90	4.14

Table 1 indicated that male students in the experimental group had a mean score of 19.01 while the female counterpart was 19.06 in the post test. This is an indication that the female students achieve higher than the male in the post test. More so, the standard deviation for the male and female students in the post test were 1.84 and 2.79 respectively, indicating that the individual scores of the male students were more clustered around the mean than those of their female counterparts that had extreme scores.

Research Question 2

What are the mean achievement scores of male and female students in Basic Science Test with expository method? Using table 2 below;

Table 2: Mean achievement score of male and female students in the control (BSAT).

	Male	(n – 73)	Female	(n – 86)
	$\bar{x}$	SD	$\bar{x}$	SD
Post test	17.96	2.31	18.13	2.44
Pretest	13.38	3.79	14.21	3.72

Table 2 indicated that male students in the control group had a mean score of 17.96 while that of their female counterparts was 18.13, an indication that female students achieved higher than the male in the post test. Similarly, the standard deviation for the male and female in the post test were 2.31 and 2.44 respectively, indicating the clustering of scores of the female students than the male.

In testing the hypotheses,

Hypothesis 1

H_{o1} – There is no significant difference between the mean achievement scores of male and female students in BSAT using Inquiry - Based - Strategy.

Vs

H_{A1}: There is significant difference between the mean achievement scores of male and female students in BSAT using Inquiry - Based – Strategy

Using the Analysis of covariance as shown on table 3 below,

Table 3 – Analysis of covariance of students' mean achievement scores in BSAT, Instructional Methods vs Gender

Source	Type lll Sum of Square	df	Mean Square	F Cal	Sign	Decision
Corrected model	68.23	3	22.74	2.76	.04	Significant
Intercepts	1140.25	1	1140.25	138.28	.00	Significant
Gender	.38	1	.38	.05	.83	Not significant
Gender x Method	62.06	2	31.03	3.76	.02	Significant
Error	2550.33	310	8.25			
Total	9752.00	314				
Corrected Total	2624.56	313				

For hypothesis 1, the ANCOVA table showed that the calculated F – value for the effect of gender on students' achievement is significant at 0.83 level of significance; this is greater than 0.05 level set for study. Hence, the null hypothesis is not rejected. This means that there is no significant difference in the mean achievement score of male and female students in BSAT.

Hypothesis 2

H_{o1}: There is no significant interaction effect between instructional strategies and genders on students' mean achievement scores in BSAT.

Vs

H_{A1}: There is no significant interaction effect between instructional strategies and genders on students' mean achievement scores in BSAT

The ANCOVA table also revealed that the F – value for the effect of interaction between gender and treatment on student achievement in the post test is 3.76 significant at 0.024 level of significance. This is less that 0.05 level set for the study. Therefore, the null hypothesis rejected no interaction effect of gender and teaching strategies on students' mean achievement scores in the post BSAT.

Discussion

Table 1 indicates that the female achieved slightly higher than the male counterparts in the post achievement test. Further investigation with the ANCOVA revealed that there is no significant difference in the achievement of male and female students in their mean achievement score. On the other hand there is a significant interaction effect of treatment and gender on students' mean scores in the post achievement test.

Evidently, these results implies that gender of students is not a major factor affecting students achievement in Basic Science Inquiry – based learning strategy emphasized on learning by participation and this could explain the non-significant gender

related difference in achievement. The learning situation that the inquiry – based strategy creates can allow students to learn in variety of ways. Students (male and female) identify problems and link them with previous knowledge. The students in a small group discuss the problem cooperatively among themselves. The above results also revealed that inquiry-based teaching method is non – sex discriminatory especially in terms of enhancing students' achievement in Basic Science. Therefore, it can be used for both boys and girls in physical classroom.

Conclusion

Based on this study, gender difference does not exist in the academic achievement of students when innovative strategies like inquiry – based teaching are employed in the teaching and learning of science subjects. Hence this method is effective in teaching science based subjects in schools.

Recommendations

- Science teachers should encourage the use of other non-sex discrimination teaching methods in enhancing students' academic achievement in Basic Science.

- Science teachers should not project science subjects as a male related subject, thereby de-emphasizing female participation.

- More constructivists - based and innovative approaches to teaching should be used to ensure that gender does not have any significant influence on achievement in science.

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