

Inquiry Innovative Teaching Strategy Impact on Biology Performance of Students in Abakaliki, Ebonyi State

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Abstract

Innovative teaching method (TM) challenges students to think deeply and creatively. Inquiry innovative teaching strategy (IITS) is needed to develop creativity and problem-solving skills in students. Conventional TM dominates the mode of impacting knowledge without considering the TM that could develop students creatively. This necessitates this research to look into the impact of IITS on Biology performance (BP) of students in Abakaliki. 83 students through Multi-stage sampling were selected. Quasi-experimental design was employed. Data collection utilized a Biology Achievement Test ($r = 0.85$). There was a significant main effect of IITS on BP of students ($F_{(1,80)} = 114.01$, $p < .05_{(0.00)}$, partial $\eta^2 = .588$). Gender has insignificant effect on students' BP. The treatment is better than conventional method in improving the students' academic performance. The study recommends that teachers should adopt the use of IITS to develop critical thinking in students which can lead to innovation and better academic performance.

Keywords: *Innovative teaching strategy, Impact on Biology performance of students Gender, Creative thinking.*

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Background to the Study

It is a necessity for teaching and learning activities to move beyond garbage in garbage out method of impacting knowledge through a stereotyped method of teaching that does not accommodate critical thinking. Innovative teaching is a teaching method that challenges students to think deeply and creatively. It is compulsory in this modern age classroom teaching to develop creativity, critical thinking and problem-solving skills in secondary school students, especially in science subjects. Inquiry based teaching strategy is an important innovative strategy to activate students' reasoning to a level of becoming critical thinkers. The past educational practices by conventional method have limited creativity in Nigerian students; researchers have emphasized the importance of interactive teaching method to minimize the limitation but with a little attention to the relevance of innovative teaching strategy. This study aims at encouraging students to engage more in the learning process through innovative inquiry study to improve their academic performance and develop critical thinking in them.

This study is positioned within Vygotsky's constructivism theory which emphasize that knowledge is co-constructed through interaction and collaboration, and every learner thinks about the knowledge to organize, intensify, and expand it. This theory has implications on how students are taught, with a focus on active learning. If the students are given chance to participate in learning actively through inquiry, their thought process is activated to give meaningful creative answer. Development of student's thought process through innovative inquiry teaching and learning is an overlooked approach in the process of teaching, and this is important to improve student's performance. If students are allowed to ruminate over a topic of teaching critically by asking them application question in relationship to the topic and the real-world situation, it gives room to the development of innovative ability in students according to Qamariyah et al (2021) inquiry-based learning develop critical thinking ability in students and enable them to apply it to the real-world events. Innovative Inquiry based learning activates students' thought process by presenting questions on a particular teaching concept that could be solved by deep reasoning and searching for information. Gomez and Suarez (2020) found that innovative Inquiry-based learning is the best method for fostering independent thought and complex thought processes. Wheatley (2018) discovered that innovative inquiry-based learning improves student engagement in classroom and gives students deeper understanding of the teaching content. Ikechukwu (2022) found that the use of inquiry-based learning instructional strategy is good to teach Biology and improve student's academic achievement.

Qamariyah (2021) realized that Inquiry based teaching prepared students to think critically and strengthens students' higher –order thinking ability. Zhao et al (2021) observed that inquiry-based learning is more efficient than conventional teaching method. Nopiya et al (2020) noted the inquiry-based learning helps to increase students' performance, while conventional teaching method limits scientific skills in science students. Sahintepe et al (2020) discovered that inquiry-based learning builds confidence in students, improves academic performance and it is a good teaching method for students at all levels. Issaka

(2020) found that inquiry-based method of teaching allows Students to interact with their environment and see the abstract phenomenon in a concrete way rather than rote study or cramming, it gives room for comprehension of the scientific material, this also aids retention hence improving performance. Also, the method helps in preparing future scientists because it helps the students to experience the diverse ways scientists explore natural phenomena. Karcar & Balim (2021) said inquiry-based learning helps to develop critical thinking in learners and help them to understand the teaching content. Weissman (2023) found that inquiry-based strategy is a potent strategy of teaching that engages students and increases performance. Gender as a variable relevant in this study, it includes a range of physical, biological, mental, and behavioral traits that distinguish between the male and female. It implies the attribute of being male or female, man or woman, boy or girl (male or female student). Musimenta et al (2020) discovered that Males students perform better in Mathematics and Science subjects than female students. According to Awodum (2015) female students generally prefer subjects such as Home Economics and primary biology, whereas chemistry, physics, mathematics, and further mathematics are predominantly chosen by male students. Essel, Viachopoulos & Tachie-menson (2021) found that Gender has minimal influence on performance of students.

Statement of the Problem

The process of teaching and learning is an Educational practice that needs to be embarked on with full consideration of carrying students along with student centered and innovative teaching strategy, but it had been observed from the time immemorial that most teachers use conventional method of teaching, which does not give room to the students participation, a very few number of teachers that center their teachings on students through interactive method of teaching do not involve innovative teaching strategy in their teachings. Most students still find it difficult to remember what they have learnt and read in biology which has negative effects on their performance in biology, and those that could even remember could not answer technical question that involves application of knowledge from Biology learning in examination. Korkman & Metin (2021) said inquiry learning helps students to retain teaching content and increase students' performance. According to Qamariyah (2021) inquiry learning strategy develop critical thinking skills in learners, which help them apply the gained knowledge on the present-day events. The act of limiting students to a direct question from the content of teaching is a big problem that needs to be addressed through innovative teaching strategy. To prepare students for the acts of creativity and good performance in Biology, innovative teaching strategy cannot be underestimated in the classroom teachings at all categories of education. This prompts this study to look into Inquiry Innovative teaching strategy impact on Biology performance of students in Abakaliki, Ebonyi State.

Purpose of the Study

This study examined the impact of inquiry innovative teaching strategy on academic performance of students in Biology. Furthermore, this study determines to know the effect of inquiry teaching strategy and gender on the academic achievement of the students in Biology.

Hypotheses

The study has two hypotheses

Ho₁: There is no significant main effect of inquiry innovative teaching strategy on the Performance of Biology students

Ho₂: There is no significant main effect of Gender on students' Biology performance.

Research Methodology

The study adopted pretest- posttest, control group, quasi experimental design. The target population comprised a sample of 83 Senior Secondary School students in Biology. This study adopted the multi-stage sampling technique, first and foremost. Finally, three secondary schools were randomly selected through random sampling; the three sampled schools were assigned to groups. One school was assigned to control group while the remaining two schools were randomly distributed to two experimental groups. The instrument for data collection which is Biology Achievement Test (BAT) was given to students for pretest and posttest. The Biology Achievement Test was calculated by Kuder-Richards method and coefficient 0.85 was obtained. Hypotheses were tested using Analysis of Covariance (ANCOVA)

Experimental Procedures

The treatment began with conducting a pretest, after which a set of mind probing questions were asked from the students in relation to the targeted topic (Respiration). After some minutes of deep thinking with guidance, most of the students gave meaningful responses, while they were given an assignment to research on the parts difficult for them to answer. The students then gave the right answer got from their research activities in the following class, with the additional explanation from the teacher. The trend continued for weeks, at the end of the treatment the post test was administered.

Method of Data Analysis

Analysis of Covariance (ANCOVA) was conducted to compare the effectiveness of two teaching methods. The independent variable is the teaching method (Innovative Inquiry Teaching Strategy and Conventional Teaching Strategy). The dependent variable is post-test Biology achievement scores of students taught with the Innovative Inquiry Teaching Strategy (treatment group) and those taught with the Conventional Teaching Strategy (control group). Scores in Biology (Pre-test) administered before the intervention were used as covariate to control for individual differences. ANCOVA was used to identify and control independent variables that can help to explain the observed variation in the dependent variable. The hypotheses in the study were tested at 0.05 level of significance.

Result

Ho₁: There is no significant main effect of innovative inquiry teaching strategy on the performance of Biology students.

Table 1: Analysis of Covariance on differences in Post-test Biology Scores of the treatment group and the control group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2591.202 ^a	2	1295.601	128.722	.000	.763
Intercept	465.311	1	465.311	46.230	.000	.366
BAT_PRETEST	1793.721	1	1793.721	178.212	.000	.690
GROUP	1147.475	1	1147.475	114.005	.000	.588
Error	805.207	80	10.065			
Total	50869.000	83				
Corrected Total	3396.410	82				

a. R Squared = .763 (Adjusted R Squared = .757)

To test this hypothesis, ANCOVA was adopted to analyse the post-test scores of the participants on their level of achievement in Biology using the pre-test scores as covariates to ascertain if the post-experimental differences were statistically significant. Results presented in table 1 showed that there is a statistically significant difference in the adjusted mean Biology achievement scores of students exposed to the Innovative Inquiry Teaching Strategy (IITS) compared to those taught with the Conventional Strategy (CTS), $F_{(1,80)} = 114.01$, $p < .05_{(0.00)}$, partial $\eta^2 = .588$. Therefore, the null hypothesis that innovative teaching strategy has no significant main effect on Biology students' performance was not accepted. The Innovative Inquiry Teaching Strategy was found to be more effective in enhancing students' achievement in Biology. The Partial Eta Squared value of 0.588 indicates a moderate effect size, meaning the teaching strategy explains a reasonable proportion of the variance in students' performance.

Table 2: Summary of Means and Standard Deviations of the Achievement of students taught using Innovative Inquiry Teaching Strategy (IITS) and Conventional Teaching Strategy (CTS)

GROUPS	N	Pre-test Mean	Pre-test Std. Dev.	Post-test Mean	Post-test Std. Dev.	BAT Mean Gain	BAT Diff. Std. Dev.
IITS (Treatment)	46	16.17	4.88	26.70	5.80	10.53	0.91
CTS (Control)	37	17.62	5.50	20.46	5.50	2.84	0.00

Table 2: Further reveal the effectiveness of the innovative inquiry strategy. Table 2 presents the means and standard deviations of pre-test and post-test scores of students taught Biology using Innovative Inquiry Teaching Strategy (IITS) and those taught using Conventional Teaching Strategy (CTS). It is observed that students taught with the IITS had scores of

16.17, 4.88 and 26.70, 5.80 for mean and standard deviations in their pre-test and post-test respectively. Those taught using the CTS respectively had scores of 17.62, 5.50 and 20.46, 5.50 for mean and standard deviations in the pre-test and post-test. Again, it is observed that both teaching strategies had mean gains. However, students taught using the Innovative Inquiry Teaching Strategy had a higher mean gain of 10.53 in comparison to students taught using Conventional Teaching Strategy with a mean gain of only 2.84.

Ho₂: There is no significant main effect of Gender on students' Biology performance.

Table 3: Analysis of Covariance on differences in Post-test Biology Scores of male and female students in the treatment group and the control group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1453.995 ^a	2	726.997	29.942	.000	.428
Intercept	706.597	1	706.597	29.102	.000	.267
BAT_PRETEST	1453.643	1	1453.643	59.870	.000	.428
GENDER	10.268	1	10.268	.423	.517	.005
Error	1942.415	80	24.280			
Total	50869.000	83				
Corrected Total	3396.410	82				

a. R Squared = .428 (Adjusted R Squared = .414)

The hypothesis was tested using Analysis of Covariance (ANCOVA) to find out whether there is a statistically significant difference in the post-test Biology achievement scores of male and female students, after controlling their pre-test scores. The test was conducted at the 0.05 level of significance. The ANCOVA analysis in table 3 showed that there is no significant mean difference in Biology achievement scores of male and female students, $F_{(1,80)} = 0.42$, $p > 0.05_{(0.517)}$, partial on Biology achievement was upheld. This implies that gender does not contribute meaningfully to students' performance in Biology under either the Innovative Inquiry Teaching Strategy or the Conventional Teaching Strategy.

Table 4: Summary of Means and Standard Deviations of the Achievement of Male Female students taught using Innovative Inquiry Teaching Strategy (IITS) and Conventional Teaching Strategy (CTS)

GROUPS	N	Pre-test	Pre-test	Post-test	Post-test	BAT	BAT Diff.
		Mean	Std. Dev.	Mean	Std. Dev.	Mean Gain	Std. Dev.
IITS (Treatment) (Male)	16	18.06	4.57	28.19	5.14	10.13	0.57
IITS (Treatment) (Female)	30	15.17	4.81	25.90	6.05	10.73	1.23
CTS(Control (Male))	15	16.87	5.99	19.53	6.37	2.67	0.39
CTS(Control (Female))	22	18.14	5.23	21.09			

Table 4: Further reveal the insignificant effect of gender on performance. A mean achievement gain score of 10.13 was obtained as the difference in the pretest and the posttest scores of male students while a mean gain score of 10.73 was obtained in the difference of pretest and posttest of the females taught using inquiry innovative teaching strategy. While in conventional method a mean achievement gain score of 2.67 was obtained for males and a mean gain score of 2.95 was obtained for females. These mean differences in addition with the ANCOVA statistics shows no statistically significant difference in the mean achievement scores ($F_{(1,80)} = 0.42, p > 0.05_{(0.517)}, \text{partial } \eta^2 = .005$) between the male and female students taught in Biology, revealed that there is no significant main effect of Gender on students' Biology performance.

Discussion of Findings

It was hypothesized that there was no significant main effect of inquiry innovative teaching strategy on the performance of Biology students. This study showed that there was a significant main effect of inquiry innovative teaching strategy on the performance of Biology students. This corroborates the findings of Weissman (2023), Ikechukwu, (2022), Nopiya et al (2020) and Sahintepe et al (2020) that Inquiry-based learning instructional strategy in teaching Biology lessons help in the classroom to improve student's academic achievement, and that it is more effective when compared to conventional teaching method. Student's performances were improved as a result of their involvement to think deeply and their attempts to answer questions during the class period, which is in tandem with the findings of Karcar & Balim (2021) that the involvement of students through inquiry-based learning help students to think critically and gives a better understanding of the subject matter. Additionally, the Observation of Zhao et al (2021) tallies with this that Inquiry-based learning helps to increase student's performance and more effective than conventional teaching.

The Influence of Gender on Performance

Regarding the second hypothesis, the study found no significant main effect of gender on students' performance in Biology. Observations during the study indicated that both male and female students exhibited similar levels of engagement and attitudes toward the inquiry method, with no notable disparities in achievement. This finding is in line with Essel, Viachopoulos & Tachie-menson's (2021) finding that gender has minimal influence on performance of students but it contradicts the assertions of Musimenta et al (2020) that Males students perform better in Mathematics and Science subjects than female students. This study indicates that when inquiry-based methods are employed, gender does not serve as a limiting factor in academic success.

Contribution to knowledge:

This study has revealed that innovative inquiry teaching strategy is a very important and needed learning method to improve Biology performance of students and to activate the thought and reasoning ability of students to think deeply and creatively to achieve academic success. This study is an eye opener to the teachers and school administrators that innovative

process should start from the classroom teaching by inculcating the acts of creative and deep thinking in teaching and learning activities through innovative inquiry-based teaching and learning, which is the starting point for creativity to be fully established in Nigeria. This study also adds to knowledge that there is no limitation to the level individuals can be active in deep thinking as far as gender is concerned.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. **Pedagogical Shift:** Biology teachers should actively adopt innovative inquiry-based learning strategies in secondary schools to stimulate students' innovative capacities and improve academic outcomes.
2. **Professional Development:** School administrators should organize seminars and workshops for secondary school teachers. These sessions should focus on the practical application of inquiry-based methods across Biology, the general sciences, and other disciplines.
3. **Inclusivity in Engagement:** Teachers utilizing inquiry-based models must ensure that both male and female students participate equally in all classroom activities to maintain a uniform and equitable learning experience.
4. **Curricular Reform:** Curriculum planners should formally integrate innovative inquiry-based teaching and learning methods into the national curriculum across all subjects. This structural change is essential to prepare students for future innovation by instilling deep-thinking habits early in their academic journey.

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Correction report

The manuscript must conform to the following submission requirements:

- i. Font:** Times New Roman ----- DONE
- ii. Font Size:** 12-----DONE
- iii. Abstract:** Maximum of 150 words--DONE
- iv. Keywords:** 4–6 words-----DONE
- v. References:** Must be current—85 percent of the old citations were changed to the current ones. Only the most relevant old 15 percent are retained to complement the current ones
- vi. Support** the statement of the problem with empirical literature -----DONE
- vii. Plagiarism check**-----DONE. (98 percent original). Author' consent form--
Added