



Effects of Analogy and Guided Inquiry Instructional Strategies on ... Gayus, W., Et. al. (2026)

Effects of Analogy and Guided Inquiry Instructional Strategies on Academic Achievement and Interest in Biology Concepts among Secondary School Students in Adamawa State, Nigeria

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Abstract

This study investigated the effects of analogy and guided inquiry instructional strategies on students' academic achievement and interest in Biology in senior secondary schools in Adamawa State, Nigeria. The study adopted a quasi-experimental design involving a non-randomized pretest-posttest control group. A sample of 436 SS II Biology students was drawn from six schools across Yola and Gombi education zones using multistage sampling, with intact classes assigned to analogy, guided inquiry, and control groups. Data were collected using the Biology Achievement Test (BAT) and Biology Students' Interest Questionnaire, with the BAT achieving a reliability index of 0.81 using Kuder-Richardson Formula (K-R21). Mean and standard deviation were used to answer research questions, while Analysis of Covariance (ANCOVA) and Multivariate Analysis of Covariance (MANCOVA) were employed to test seven hypotheses at the 0.05 level of significance. The findings revealed that analogy and guided inquiry strategies had significant effects on students' academic achievement ($p = 0.000$) and interest in Biology ($p = 0.000$) compared to lecture methods. A significant gender effect was found on achievement ($p = 0.000$) but not on interest ($p = 0.705$). The study recommends that teachers, curriculum planners, and policymakers promote gender-inclusive, student-centered Biology instruction by integrating analogy and guided inquiry strategies into classroom teaching, teacher training, curriculum design, and professional development to enhance students' understanding, motivation, and overall achievement.

Keywords: Analogy, guided inquiry, academic achievement, interest, Biology

Introduction

Science education forms the foundation for technological advancement and national development, with disciplines such as physics, chemistry, and biology contributing uniquely to human understanding of the natural world. In Nigeria, the National Policy on Education (NPE, 2014) underscores the importance of science as an activity-based, experiential subject that fosters problem-solving skills and innovation. However, despite this recognition, student achievement in Biology at the senior secondary level has remained persistently poor. Data from the West African Examinations Council (WAEC) spanning 2017 to 2024 reveal an average credit-level pass rate of only 44.90% in Adamawa State, with yearly fluctuations that indicate inconsistent and unsatisfactory performance (WAEC Report, 2017–2024). Scholars attribute this underachievement to several



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factors, including ineffective instructional strategies, shortage of qualified teachers, inadequate instructional materials, and limited student motivation (Adesoji, 2008; Akintola, 2019). Traditional lecture methods that emphasize rote learning often fail to engage students meaningfully, prompting calls for learner-centered approaches that encourage active participation and conceptual understanding (Sakiyo & Kala, 2018; Oniya & Adefila, 2020). In response to these challenges, researchers have explored innovative instructional strategies such as analogy and guided inquiry. Analogy is an instructional approach that compares unfamiliar concepts with familiar ones to facilitate understanding, enabling students to transfer knowledge from known domains to new contexts (Abimbola, 2013; Richland & Simms, 2015). Studies by Akintola (2019) and Oniya (2020) demonstrated that analogy-enhanced instruction significantly improved students' achievement in Biology compared to conventional methods. Similarly, guided inquiry is a student-centered strategy that involves careful planning, ongoing assessment, and targeted intervention by teachers to guide students through the process of asking questions, investigating phenomena, and constructing their own understanding (Joda, Ugwuadu & James, 2024). This approach encourages learners to observe events, collect and interpret data, and take responsibility for their learning. Obadipe et al. (2020) found that guided inquiry significantly increased academic achievement in Biology relative to traditional lecture methods, while Mohammed and Joda (2017) reported that students taught with guided inquiry demonstrated higher achievement, although lecture methods were found to be more effective for content retention.

Beyond achievement, students' interest in Biology is a critical factor that influences sustained learning, curiosity, and career aspirations. Interest refers to the eagerness to explore living organisms, their functions, and their interactions with the environment, and it has been shown to enhance attention, memory retention, and active engagement (Freeman, 2017; Yan, 2021). However, research on gender differences in interest and achievement has produced inconclusive findings. While some studies reported that female students exhibited higher interest in science subjects (Onu, Anyaegbumam & Uzoigwe, 2020; Usang & Okoli, 2021), others found no significant gender differences (Okekeokosisi & Okigbo, 2021; Yunusa, Abdulwahid & Adullahi, 2014). Similarly, studies on instructional strategies revealed that analogy and guided inquiry are generally not gender-sensitive and promote achievement across both male and female students (Oniya, 2020; Obadipe et al., 2020). These persistent challenges and inconclusive findings underscore the need for further investigation into the effects of analogy and guided inquiry instructional strategies on students' academic achievement and interest in Biology, with particular attention to gender as a moderating variable.

Statement of the Problems

The persistent decline in students' academic achievement in senior secondary Biology represents a multifaceted problem rooted in the continued dominance of teacher-centered instructional methods that fail to foster deep conceptual understanding or engagement, a disconnect between an examination-focused curriculum and the development of practical, real-world skills, and a host of compounding factors including insufficient qualified teachers, inadequate laboratory infrastructure, and overcrowded classrooms. This crisis is empirically underscored by consistently poor performance in external examinations, such as WAEC's 2015 record showing only 38.47% of over a million candidates achieving a credit pass, and NECO Chief Examiners' Reports from 2018 to 2023 that repeatedly cite widespread underachievement in Biology alongside other sciences. Compounding these issues is the abstract nature of key Biology topics like genetics and ecology, which are difficult to convey through passive learning, alongside persistent gender-related disparities that continue to



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affect achievement outcomes. Consequently, this study is designed to address these core problems by investigating whether innovative, constructivist-aligned strategies namely analogy and guided inquiry can significantly enhance students' academic achievement and interest in Biology, and crucially, whether these approaches can mitigate the existing achievement gap between male and female students.

Purpose of the Study

The main purpose of this study is to investigate the Effects of Analogy and Guided Inquiry Instructional Strategies on Students' Academic Achievement and Interest in Biology in Senior Secondary Schools in Adamawa State, Nigeria. Specifically, the study to determines:

1. The effect of analogy, guided inquiry instructional strategies and lecture method on students' academic achievement in Biology.
2. The effects of analogy, guided inquiry instructional strategies and lecture method on student interest in biology.
3. The effects of analogy, guided inquiry instructional strategies on students' academic achievement based on gender.

Research Questions

The following research questions were raised to guide the study:

1. What are the pretest and posttest mean achievement score of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture method?
2. What are the pretest and posttest mean interest scores of students taught biology using analogy, guided inquiry instructional strategies and lecture method in Adamawa state?
3. What are the pretest and posttest mean achievement score of students taught biology using analogy and guided inquiry instructional strategies based on gender in Adamawa state?

Hypotheses

The following null hypotheses were formulated and were tested at 0.05 level of significance.

- H₀₁: There is no significant difference in the academic Achievement of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture Strategy in Adamawa state.
- H₀₂: There is no significant difference in the student interest when taught Biology using Analogy, guided inquiry instructional strategy and lecture method in Adamawa state.
- H₀₃: There is no significant gender difference on senior secondary school students' academic Achievement in biology when taught analogy and guided inquiry instructional strategies.

Research Methodology

The study employed a quasi-experimental design, specifically a non-randomized pretest-posttest control group approach, to examine the effects of instructional strategies on students' achievement and interest in Biology, with quasi-experimental designs being appropriate when random assignment is impractical and permits the use of intact classes (Eliopoulos, 2004; Offor, 2000; Sambo, 2005). The study was conducted in Adamawa State, Northeastern Nigeria, a region with a diverse population, agricultural economy, and well-established educational infrastructure, and the population consisted of all 48,760 SSII students offering Biology in the 384 public senior secondary schools (Post Primary School Management Board, 2025). A sample of 436 SSII students from six selected schools in Yola and Gombi zones was chosen using a multistage sampling technique involving simple random sampling to identify zones, purposive sampling to select schools meeting inclusion criteria (co-educational status, functional Biology laboratories, qualified teachers), and



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assignment of intact classes to experimental groups (Analogy and Guided Inquiry) and a control group (conventional lecture-based instruction). Two instruments were used for data collection: the Biology Achievement Test (BAT), a 50-item multiple-choice test adapted from WAEC past questions (2019–2024) aligned with the SSII Biology curriculum focusing on ecology, genetics, and the circulatory system, and the Biology Students’ Interest Questionnaire (BSIQ), a standardized 5-point Likert scale questionnaire validated against Hidi and Renninger’s (2006) Four-Phase Model of Interest Development, with reliability indices of 0.81 and 0.82 respectively. Students were pre-tested to establish baseline equivalence, after which the intervention lasted six weeks with four trained research assistants delivering lessons under supervision using structured lesson plans, followed by post-test and post-interest assessments. Collected data were scored, coded, and analyzed using SPSS version 25, with descriptive statistics (mean and standard deviation) answering research questions and inferential statistics (ANCOVA and MANCOVA) testing hypotheses at the 0.05 significance level.

Presentation Of Results

Answers to research Questions

Research Question 1: What are the pretest and posttest mean achievement score of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture Strategy in Adamawa state?

Table 1: Mean and Standard Deviation of Pre – Test and Post Test Scores Difference of Students taught Biology using Analogy, Guided Inquiry and Lecture Instructional Strategies

Group	n	Pre – test		Post – test		Mean difference
		M	S. D	M	S. D	
Analogy	140	23.24	4.07	33.94	6.16	10.70
Guided inquiry	142	22.76	3.43	29.05	4.19	6.29
Lecture	154	21.83	5.01	24.17	3.24	2.34

Table 1 shows that students in the analogy group had the highest gain (pretest mean = 23.24, SD = 4.07; posttest mean = 33.94, SD = 6.16; mean difference = 10.70), followed by the guided inquiry group (pretest mean = 22.76, SD = 3.43; posttest mean = 29.05, SD = 4.19; mean difference = 6.29), and finally the lecture group (pretest mean = 21.83, SD = 5.01; posttest mean = 24.17, SD = 3.24; mean difference = 2.34). While all three instructional strategies led to significant improvements in students’ Biology achievement, the analogy strategy produced the most substantial gain, followed by guided inquiry and then the lecture method.

Research Question 2: What are the pretest and posttest mean interest scores of students taught biology using analogy, guided inquiry instructional strategies and lecture method in Adamawa state?

Table 2. Descriptive Analysis of Students’ Pretest and Posttest Mean Interest Scores of Experimental and Control Groups

Group	n	Pre – test		Post – test		Mean difference
		M	S. D	M	S. D	
Analogy	140	2.35	0.22	2.96	0.33	0.61
Guided inquiry	142	3.09	0.76	3.47	0.26	0.38
Lecture	154	2.17	0.35	2.38	0.51	0.21

Table 2 reveals that the analogy group recorded the highest gain in mean interest scores (pretest mean = 2.35, SD = 0.22; posttest mean = 2.96, SD = 0.33; mean difference = 0.61), followed by the guided inquiry group (pretest mean = 3.09, SD = 0.76; posttest mean = 3.47, SD = 0.26; mean



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difference = 0.38) and the lecture group (pretest mean = 2.17, SD = 0.35; posttest mean = 2.38, SD = 0.51; mean difference = 0.21). Thus, while all three instructional strategies improved students' interest in Biology, the analogy strategy produced the most substantial increase, with guided inquiry also showing a notable improvement over the conventional lecture method.

Research Question 3: What are the pretest and posttest mean achievement score of students taught biology using analogy and guided inquiry instructional strategies based on gender in Adamawa state?

Table 3: Mean and Standard Deviation of Pre – Test and Post Test Scores Difference of Male and Female Students taught Biology using Analogy and Guided Inquiry Instructional Strategies

Group	Gender	n	Pre – test		Post – test		Mean difference
			M	S. D	M	S. D	
Analogy	Male	62	17.62	4.17	26.83	4.69	9.21
	Female	78	14.03	3.04	22.66	3.05	8.63
Guided inquiry	Male	67	13.07	3.28	19.78	5.30	6.71
	Female	75	15.27	3.63	22.71	6.79	7.44

Across all three instructional strategies, both male and female students demonstrated improved achievement in Biology, with the analogy group yielding the largest mean score gains for both genders (males: +9.21; females: +8.63). Notably, male students showed slightly higher gains than females in the analogy groups, while in the guided inquiry group, females outperformed males with a mean difference of 7.44 compared to 6.71.

Testing the Hypotheses

HO₁: There is no significant difference in the academic Achievement of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture Strategy in Adamawa state.

Table 4: One-way Analysis of Covariance of Students' Academic Achievement when Taught Biology with Analogy, Guided Inquiry Instructional Strategy and Lecture Strategy

Source	Type III Sum of Square	Df	Mean Square	F	Partial Eta Square	Sig.
Corrected Model	130514.687 ^a	3	60804.609	270.604	0.538	0.00
Intercept	114845.077	1	114845.077	420.275	0.451	0.00
PRETEST	410.764	1	410.764	2.301	0.004	0.102
Strategy	120575.367	2	64321.758	281.359	0.7056	0.00*
Error	86215.043	434	156.874			
Total	1208507.000	436				
Corrected total	226742.570	435				

a. R Squared = .628 (Adjusted R Squared = .636); * =The mean difference is significant at the 0.05 level.

Table 4 revealed that there is significant difference of analogy, guided inquiry instructional strategy and lecture Strategy on the mean academic Achievement scores of students, $F_{(3, 434)} = 281.359$, $P < 0.05$. Since the computed P-value (0.000) is less than 0.05 the null hypothesis is rejected. This implies that there is significant difference of teaching Strategy on students' academic Achievement in biology. Thus, students performed significantly differently in the three groups. This implies that the teaching Strategy may not be equally effective. Also, there is strong relationship between pretest and post test scores as indicated by partial eta squared value of 70.5%. This shows that the teaching Strategy are effective in enhancing student academic achievement in biology.



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HO₂: There is no significant difference in the student interest when taught Biology using Analogy, guided inquiry instructional strategy and lecture method in Adamawa state.

Table 5: One-way Analysis of Covariance of Students' Interest when Taught Biology with Analogy, Guided Inquiry Instructional Strategies and Lecture Strategy

Source	Type III Sum of Square	Df	Mean Square	F	Partial Eta Square	Sig.
Corrected Model	7.483 ^a	3	2.027	6.024	0.032	0.00
Intercept	135.760	1	135.760	425.209	0.350	0.00
Interest before	0.310	1	0.310	0.654	0.003	0.334
Strategy	6.356	2	3.084	11.781	0.332	0.00*
Error	151.021	434	0.336			
Total	7203.182	436				
Corrected total	175.603	435				

a. R Squared = .043 (Adjusted R Squared = .036); * =The mean difference is significant at the 0.05 level.

Table 5 revealed that there is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on students' interest to biology, $F(3, 434)=11.781$, $P<0.05$. Since the computed P-value (0.000) is less than 0.05, the null hypothesis is rejected. This implies that there is significant effect of teaching Strategy on students' interest to biology. Also, there is strong relationship between pretest and posttest interest scores as indicated by the partial eta squared value of 3.3%. This shows that the students' interest to biology is affected by teaching Strategy in enhancing student academic Achievement in biology.

HO₃: There is no significant gender difference on senior secondary school students' academic Achievement in biology when taught analogy and guided inquiry instructional strategies.

Table 6: Summary of Independent Sample t – Test of Students' Academic Achievement Based on Gender when Taught Biology with Analogy and Guided Inquiry Instructional Strategies

Achievement scores	Gender	N	Mean	S. D	DF	t – value	P – value	Remarks
for students taught using analogy	M	62	38.67	10.75	139	5.01	0.000	H ₀₃ rejected
	F	78	25.80	12.46				
for students taught using guided inquiry	M	67	28.53	11.01	141	-3.37	0.000	H ₀₃ rejected
	F	75	31.17	13.79				

From Table 6, presents the analysis of independent sample *t* – test of students' academic Achievement based on gender when taught biology with analogy and guided inquiry instructional strategies. For students taught using analogy strategy $t= 5.01$; $df=(1, 139)$, $P<0.05$. Since the computed P-value (0.000) is less than 0.05 level of significance, the null hypothesis is rejected. This implies that there is significant gender difference on students' academic Achievement in biology when taught with analogy. Also, For students taught using guided inquiry, $t=3.37$, $df = (1, 141)$, $P<0.05$. Since the computed P-value (0.000) is less than 0.05 level of significance, the null hypothesis is rejected. This implies that there is significant gender difference on students' academic Achievement in biology when taught with guided inquiry.

Summary of Major Findings

The major findings of the study are as follows:



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1. There is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on the academic Achievement of students in Biology ($p=0.000 < 0.05$).
2. There is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on students' interest to biology ($p=0.000 < 0.05$).
3. There is significant gender effect on students' academic Achievement in biology when taught with analogy and guided inquiry instructional strategies ($p=0.000 < 0.05$).

Discussion of Findings

There is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on the mean academic Achievement scores of students. This finding agree with Musa (2020) revealed that students taught using analogy-based instruction significantly outperformed those taught using the conventional Strategy. Indicating that analogy-based instruction enhanced students' comprehension and retention of biological concepts. In the same vein, Obinna (2022) results indicated that students in the guided inquiry group significantly outperformed those in the lecture-based group. Sharma (2019) showed that students taught through guided inquiry significantly outperformed those in the control group, with a mean posttest score significantly higher than their counterparts. Similarly, Ahmed (2021) who revealed that guided inquiry and analogy-based instruction significantly improved students' academic Achievement compared to the conventional lecture Strategy in biology. However, guided inquiry yielded a higher mean score than analogy-based instruction, indicating that it was more effective in fostering students' understanding of Biology concepts. On the contrary to the present study revealed that analogy is better than guided inquiry and lecture Strategy. This suggested that analogy-based instruction helped students relate abstract biological concepts to familiar real-life situations, which enhanced comprehension.

The findings revealed that there is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on students' interest to biology. This finding agreed with Martínez and López (2020) experimental group demonstrated a significant improvement in both interest and achievement compared to the control group. Martínez and López found that guided inquiry-based instruction positively influences students' academic Achievement and cultivates a heightened interest in Biology. Also, Mensah and Boateng (2020) found that guided inquiry-based learning enhanced students' interest in Biology. Similarly, Sari and Yusuf (2020) revealed that students taught through analogy-based strategies scored significantly higher than those taught via traditional Strategy. Additionally, the experimental group exhibited a greater interest in Biology. The study also revealed that there is significant gender difference on students' academic Achievement in biology when taught with analogy and guided inquiry instructional strategies. This finding agreed with Zhao and Liu (2021) reported that female students tend to outperform their male counterparts in Biology, particularly when the curriculum includes real-world applications such as healthcare and environmental science. This aligns with findings from Sukoco and Kurniawan (2020), who noted that female students typically show more engagement with topics like ecology and environmental conservation, which are perceived as more relatable, while male students demonstrate greater interest in technical aspects such as genetics and biotechnology. On the other hand, Bamberg and Miller (2020) demonstrated that male students tend to perform better in competitive classroom environments focused on factual recall, whereas female students show more persistence in tasks requiring conceptual understanding and critical thinking. On the contrary, Ferrer et al. (2021) found that while male and female students perform similarly in standardized Biology tests, female students excel in applied knowledge tasks, such as solving real-world biological problems, which require critical thinking and application of knowledge.



Conclusion

The study shows that analogy and guided inquiry instructional strategies were significantly effective and improved students' academic Achievement when compared with lecture method when taught biology in senior secondary schools in Adamawa state. The study also showed that gender had an influence on students' Achievement, although it did not significantly affect their interest in Biology. Analogy and guided inquiry instructional strategies are effective tools for enhancing teaching and learning in Biology. When properly implemented, these Strategy make lessons more engaging, promote deeper understanding, and stimulate students' curiosity and motivation to learn.

Recommendation

Based on the findings of the study, the following were recommended:

1. Biology teachers should adopt analogy and guided inquiry instructional strategies in their teaching to enhance students' understanding and academic achievement.
2. Teachers should receive continuous training and professional development on the effective use of analogy and guided inquiry strategies to improve instructional delivery and classroom effectiveness.
3. Teachers and curriculum planners should ensure that teaching materials and strategies are gender-inclusive to promote equal learning opportunities and minimize Achievement disparities between male and female students.

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