Effect of Inquiry-Based Instructional Strategy on Senior Secondary Students' Interest, Achievement and Retention in Biology in Federal Capital Territory, Abuja

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Abstract
This study investigated the effect of inquiry-based instructional strategy on senior secondary students' interest, achievement and retention in Biology in Federal Capital Territory, Abuja. The study was guided by six research questions and six hypotheses. The quasi-experimental research design was employed for the study. The population of the study composed of eight-eight thousand, seven hundred and twenty-one (88,721) students in the eighty-eight (88) public senior secondary schools in the FCT, Abuja. Sample size of one hundred and twenty-two (122) senior secondary school two (SS II) students from two intact classes. Data of the study were collected using Biology interest assessment scale, Biology achievement test, and Biology retention test with the following corresponding reliability indices of 0.86, 0.82, and 0.79 respectively. Data obtained were analyzed using the descriptive statistics and the independent samples t-test statistics. It was found that students taught Biology using the inquiry-based instructional strategy had significantly higher interest, academic achievement, and retention scores compared to those taught with the conventional teaching method. There were no significant differences in interest, academic achievement, and retention scores between male and female students taught Biology using the inquiry-based instructional strategy. It was concluded that the inquiry-based instructional strategy has significant effect on students' interest, academic achievement, and retention in Biology without gender bias. It was recommended, among others, that curriculum planners should incorporate inquiry-based instructional strategy into teaching methods for Biology in senior secondary schools to enhance the interest, academic achievement, and retention of students, and teachers should be encouraged to apply the inquiry-based instructional strategy to enhance students' interest, academic achievement, and retention for effective knowledge transfer.

Keywords: *Inquiry-based Instruction, Biology, Interest, Academic Achievement, Retention, Gender*

Introduction

Effective teaching at the secondary school level is crucial to the development of learners' intellectual, social, and practical competencies. Secondary education serves as an important bridge between basic and higher education by providing learners with a broad knowledge base, developing critical thinking and problem-solving abilities, and preparing them for further education and future careers (Ekpo & Is'haq, 2014; Ali et al., 2020). In Nigeria, senior secondary education provides opportunities for students to develop specialized knowledge in different subject areas, particularly in the sciences (Dambana & Danjuma, 2023). Biology is one of the major

science subjects at this level and contributes significantly to students' understanding of living organisms, health, environmental issues, genetics, biodiversity, and related scientific phenomena (Enebechi, 2021). It also provides foundational knowledge for careers in medicine, biotechnology, agriculture, environmental science, and other life-science-related fields (James et al., 2024).

The importance of Biology, however, depends considerably on the quality of instructional delivery. Biology contains concepts that require learners not only to acquire factual knowledge but also to observe, investigate, interpret evidence, establish relationships, and apply scientific principles to real-life situations (Mwenda & Ndayambaje, 2021). Consequently, instructional approaches that actively involve students in the learning process are increasingly relevant. Inquiry-based instructional strategy is one such student-centred approach (Sylvanus & Eke, 2017). It engages learners in asking questions, exploring phenomena, investigating problems, and constructing knowledge through individual or collaborative activities, while the teacher functions mainly as a facilitator of learning (Saba et al., 2019). Through such active engagement, learners have opportunities to develop critical thinking, problem-solving, collaboration, and deeper conceptual understanding. The effectiveness of Biology instruction can be examined through several learner outcomes, particularly interest, academic achievement, and retention. Students' interest reflects their willingness, attention, motivation, and sustained engagement in learning activities (Dambana, & Danjuma, 2023). When learners develop interest in Biology, they are more likely to participate actively and persist in learning tasks. Academic achievement, on the other hand, indicates the extent to which students attain the intended knowledge, skills, and competencies, usually demonstrated through assessment scores (Issaka, 2018). Retention refers to students' ability to remember and recall previously acquired knowledge and apply it over time. These outcomes are interconnected because sustained interest can encourage engagement with learning tasks, while meaningful learning experiences can enhance both achievement and retention (Ibrahim et al., 2018). Despite the relevance of Biology to scientific and technological development, concerns remain regarding students' inadequate interest, unsatisfactory academic achievement, and poor retention of biological concepts (James et al., 2024). The continued use of predominantly traditional teaching approaches, characterised by teacher exposition, passive participation, and memorisation, may provide limited opportunities for students to investigate concepts and construct understanding through direct engagement (Enebechi, 2021). Inquiry-based instructional strategy, according to Adejo (2015), Annan et al. (2019) and, Dushimimana and Mugabo (2022) offers a possible alternative because it places greater responsibility on learners to ask questions, investigate problems, interpret findings, and develop explanations. Such experiences may make Biology learning more meaningful and potentially improve students' learning outcomes.

Nevertheless, the effectiveness of an instructional strategy may not be uniform across all categories of learners. Gender has continued to attract attention in educational research because differences in learning experiences, motivation, preferences, and social expectations may influence how students respond to instructional approaches. Examining gender as a moderating variable can therefore provide evidence on whether inquiry-based instruction produces comparable outcomes among male and female students. Although inquiry-based instructional strategy has been associated with improved engagement and learning outcomes, there remains a need for empirical evidence concerning its specific effects on students' interest, academic achievement, and retention in senior secondary Biology, particularly within the Federal Capital Territory (FCT), Abuja. In addition, limited attention has been given to the moderating role of gender in the relationship between inquiry-based instruction and these learning outcomes. Therefore, this study investigated

the effect of inquiry-based instructional strategy on senior secondary students' interest, academic achievement, and retention in Biology in the FCT, Abuja, with gender as a moderating variable.

Purpose of the Study

The goal of this study is to investigate the effect of inquiry-based instructional strategy on senior secondary students' interest, achievement and retention in Biology in Federal Capital Territory, Abuja. Specifically, the study:

i. examine the difference between the mean interest scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method.
ii. assess the difference between the mean academic achievement scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method.
iii. explore the difference between the mean retention scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method.
iv. examine the difference between the mean interest scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy.
v. assess the difference between the mean academic achievement scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy.
vi. explore the difference between the mean retention scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy.

Research Questions

In line with the above objectives, the following research questions were raised as guidance for the study:

i. What is the difference between the mean interest scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method?
ii. What is the difference between the mean academic achievement scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method?
iii. What is the difference between the mean retention scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method?
iv. What is the difference between the mean interest scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy?
v. What is the difference between the mean academic achievement scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy?
vi. What is the difference between the mean retention scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy?

Hypotheses

The following hypotheses were formulated based on the above research questions (and tested as 0.05 level of significance):

H_{01}: There is no significant difference between the mean interest scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method.

H_{02}: There is no significant difference between the mean academic achievement scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method.

H_{03}: There is no significant difference between the mean retention scores of senior secondary school students taught Biology using the inquiry-based instructional strategy and those taught using the conventional teaching method.

H_{04}: There is no significant difference between the mean interest scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy.

H_{05}: There is no significant difference between the mean academic achievement scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy.

H_{06}: There is no significant difference between the mean retention scores of male and female senior secondary school students taught Biology using the inquiry-based instructional strategy.

Conceptual Framework

Conceptual framework is a visual or written representation of a systematic structure that outlines the variables of a study, and their relationships. It is a blueprint or roadmap for the research process. The conceptual framework for the present study is presented thus:

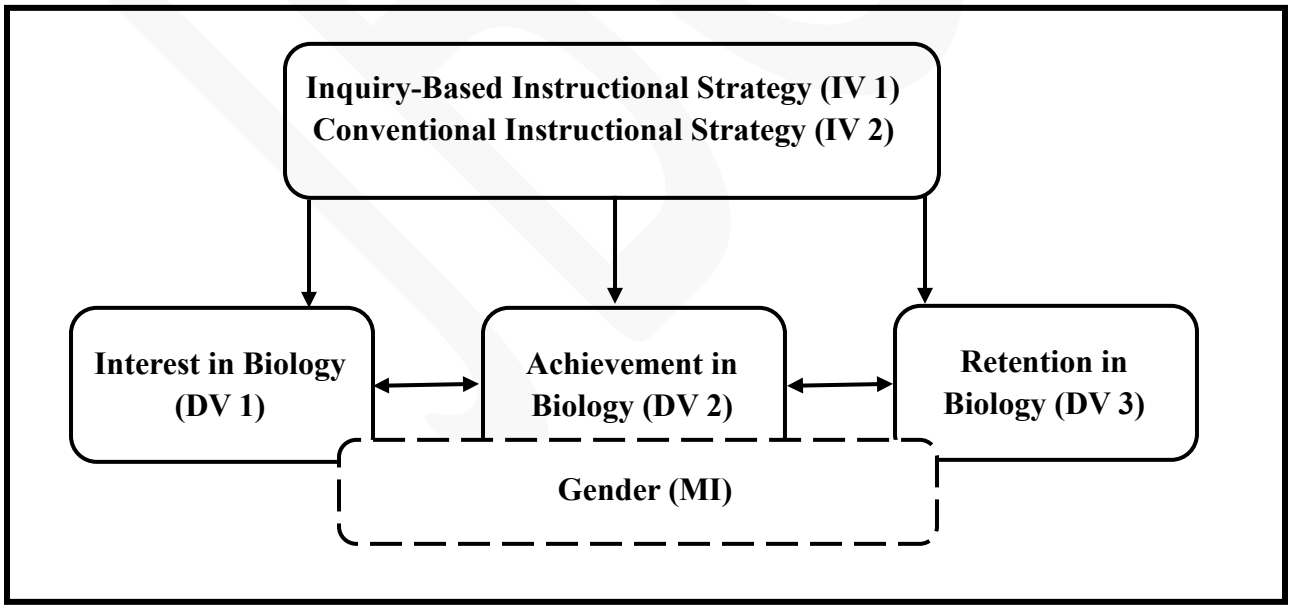

Figure 1: Conceptual Framework

The conceptual framework presents the relationships among the independent variables, dependent variables, and moderating variable. The independent variables are inquiry-based instructional

strategy (IV_1), which actively engages students through questioning, exploration, investigation, and experimentation, and conventional instructional strategy (IV_2), which is predominantly teacher-centred. The dependent variables are interest in Biology (DV_1), academic achievement in Biology (DV_2), and retention in Biology (DV_3), representing students' engagement, academic performance, and ability to recall and apply learned knowledge, respectively. Gender serves as the moderating variable to determine whether the effects of the instructional strategies on the three learning outcomes vary between male and female students. The framework therefore assumes that inquiry-based instruction may produce more favourable learning outcomes through active participation and critical thinking, while the effectiveness of either instructional strategy may vary according to students' gender.

Empirical Review

Empirical evidence on inquiry-based instructional strategy has consistently examined its application across different subjects and educational levels, particularly its influence on students' academic outcomes. Early evidence was provided by Adejo (2015), who investigated the effect of inquiry-based teaching on the academic performance of 120 SS II Chemistry students in Kaduna State using a quasi-experimental design. Data collected with the Chemistry Achievement Test (CAT) were analysed using an independent-samples *t*-test. The findings showed that students taught through inquiry-based instruction performed significantly better than those taught using traditional methods, suggesting the potential of inquiry-oriented teaching to improve students' academic performance. Further evidence was reported by Mensah-Wonkyi and Adu (2016), who examined inquiry-based teaching and conceptual understanding among 79 senior high school students in Ghana. Using a quasi-experimental design, tests, questionnaires and interviews were administered, while same-sample and independent-samples *t*-tests were used for analysis. The findings indicated improved conceptual understanding following instruction, with students exposed to inquiry-based teaching recording better outcomes and higher motivation. Similarly, Sylvanus and Eke (2017) examined inquiry teaching among 120 senior secondary Chemistry students in Rivers State. Using a quasi-experimental design and Chemistry Achievement Test, analysed through two-sample *t*-test and ANCOVA, the study found that inquiry-based teaching enhanced academic performance. The effectiveness of inquiry-based instruction was subsequently extended to achievement and retention outcomes. Ibrahim, Hamza, Bello and Adamu (2018) investigated inquiry and lecture methods among 256 NCE I Chemistry students in Zaria using a pre-test, post-test quasi-experimental design. The Separation Techniques Chemistry Achievement Test, with a reliability coefficient of 0.88, was used for data collection, and *t*-test was employed for analysis. The findings indicated that inquiry instruction significantly improved students' achievement and retention. In the same vein, Nwafor and Nwanekezi (2018) examined guided inquiry and task hierarchy analysis within cooperative learning among 163 Chemistry students in Imo State. Using a non-equivalent quasi-experimental design, the Chemistry Performance Test on Acid-Base Reactions and ANCOVA, the study found that guided inquiry and task hierarchy analysis were more effective than lecture instruction in improving understanding and retention.

Evidence from Integrated Science also reinforced the role of inquiry-based instruction in sustaining learning outcomes. Issaka (2018) investigated inquiry-based teaching among 292 senior high school students in Ghana using achievement and retention tests. The findings indicated that students exposed to inquiry-based instruction achieved better performance and demonstrated higher retention than those taught through traditional methods. Similarly, Azowenunebi, Adeyemo and Babajide (2019) examined inquiry-based instruction among 173 senior secondary Physics

students in Lagos State. Using a quasi-experimental design, Practical Physics Achievement Test, descriptive statistics and ANCOVA, the study found that inquiry instruction significantly improved academic achievement, with no significant gender difference.

The application of inquiry-based instruction to Biology has also received empirical attention. Annan, Adarkwah, Abaka-Yawson, Sarpong and Santiago (2019) examined inquiry-based instruction among 101 second-year Biology students in Ghana using a quasi-experimental pre-test, post-test design. Data obtained through a Researcher-Made Biology Test were analysed using mean, standard deviation and *t*-test. The findings revealed a significant difference in achievement in favour of students taught through inquiry instruction. Similarly, Ali, Adamu, Kuta and Tukura (2020) examined inquiry-based instruction and retention of Biology concepts among 93 SS II students in Niger State. Using a quasi-experimental design, Biology Retention Test and ANOVA, the study found that inquiry-based instruction improved students' retention compared with traditional instruction, without significant gender differences.

The focus of inquiry-based research subsequently expanded beyond achievement and retention to include students' interest and affective outcomes. Ijeh (2020) investigated inquiry-based instructional strategy and students' interest and achievement among 359 Mathematics students in Delta State. Using Mathematics Achievement Test and Mathematics Interest Inventory Scale, with descriptive statistics and ANOVA for analysis, the study found that inquiry-based instruction improved both interest and achievement. Similarly, Dambana and Danjuma (2023) examined inquiry-based instruction and interest in Ecology among 118 senior secondary Biology students in Kaduna State. Using a quasi-experimental design and the Students' Ecology Concept Interest Questionnaire, analysed with Wilcoxon and Mann–Whitney statistics, the study reported a significant improvement in students' interest following inquiry-based instruction.

Research specifically addressing Biology achievement and retention continued to provide supporting evidence. Enebechi (2021) investigated inquiry-based instruction among 139 SS II Biology students in Enugu State using Biology Achievement and Retention Tests. Descriptive statistics and ANCOVA were employed, and the findings indicated that inquiry-based instruction enhanced both achievement and retention without significant gender differences. Likewise, Mwenda and Ndayambaje (2021) examined inquiry-based teaching among 94 secondary school Biology students in Tanzania. Using a quasi-experimental design, Biology Achievement Test, descriptive statistics and independent-samples *t*-test, the study found higher achievement among students taught through inquiry-based instruction.

Other studies examined inquiry-based instruction alongside alternative instructional approaches. Chibueze and Okoye (2021) investigated cooperative and inquiry instructional methods among 60 technical college students studying Basic Electricity in Anambra State. Using a quasi-experimental design, the Basic Electricity Achievement Test and ANCOVA, the findings showed that cooperative learning was more effective than inquiry instruction in facilitating achievement and retention. In contrast, Danjuma and Mankilik (2022) found that inquiry-based instruction was more effective than lecture instruction in improving achievement and retention among 150 SS II Chemistry students in Taraba State.

Recent evidence has further demonstrated the applicability of inquiry-based approaches to both cognitive and affective outcomes. Dushimimana and Mugabo (2022) examined inquiry-based teaching and students' performance and attitudes toward Chemistry among 78 senior secondary students in Rwanda. Using a quasi-experimental design, Chemistry Achievement Test and Chemistry Attitudes Questionnaire, with *t*-test and ANCOVA, the study found improved performance and attitudes following inquiry-based instruction. Owolade, Salami, Kareem and

Oladipupo (2022) examined guided and open inquiry among 118 SS I Biology students in Osun State. Using the Biology Achievement Test and ANCOVA, the study found significant differences among the instructional groups, with open inquiry producing the highest academic performance.
More recent Nigerian studies have continued to demonstrate the relevance of inquiry-based strategies across educational contexts. Olawuwo, Bello, Babagana and Zubairu (2024) investigated guided inquiry and problem-solving approaches among 373 students in Unity Colleges across North-Central Nigeria. Using a quasi-experimental design and the Basic Science and Technology Students' Achievement Test, the study employed descriptive statistics and ANCOVA. The findings showed that guided inquiry and problem-solving approaches significantly improved achievement and retention without significant gender effects. Edevwie, Obi and Okoye (2024) examined reflective inquiry and practical skills among 93 Technical College students in Delta State. The study used a quasi-experimental design and the Electrical Installation and Maintenance Works Test, with descriptive statistics and ANCOVA for analysis. The findings indicated higher performance among students exposed to reflective inquiry, although female students performed better than male students.
Similarly, James, Joda and Ugwuadu (2024) examined guided inquiry and academic performance and retention among 156 SS II Biology students in Adamawa State. Using Biology Performance and Retention Tests and ANCOVA, the study reported significant effects of guided inquiry on students' academic performance and retention, together with gender-related interaction effects. Emmanuel, Olodu, Omebe, Egbe and Elom (2024) also examined guided inquiry among 134 junior secondary Basic Science students in Delta State. Using the Basic Science Achievement Test and ANCOVA, the findings showed that guided inquiry was more effective than lecture instruction in improving achievement and retention, with no significant gender interaction.
Generally, the reviewed empirical evidence demonstrates sustained scholarly interest in inquiry-based instructional strategies across Chemistry, Biology, Physics, Mathematics, Integrated Science, Social Studies, History, Basic Science and technical education. The studies have predominantly employed quasi-experimental designs and have assessed outcomes including academic achievement, conceptual understanding, retention, interest, attitudes and practical skills. Although most findings indicate positive effects of inquiry-based instruction, the evidence also shows that its effectiveness may vary according to the instructional approach, subject context and outcome being assessed. These empirical patterns provide a basis for further examination of inquiry-based instructional strategy as an approach for improving students' interest, achievement and retention in Biology.

Theoretical Framework

The study is anchored on Experiential Learning Theory and Self-Determination Theory. Experiential Learning Theory, developed by Kolb (1984), explains learning as a continuous process through which knowledge is constructed by transforming experience. The theory comprises four interconnected stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. These stages closely correspond with inquiry-based instruction, in which students actively investigate biological phenomena, reflect on findings, develop explanations, and apply acquired knowledge to new situations. Such active and experiential engagement is expected to enhance students' interest, academic achievement, and retention in Biology. The Self-Determination Theory, developed by Deci and Ryan (1985), explains motivation in terms of the satisfaction of three basic psychological needs: autonomy, competence, and relatedness. Inquiry-based instruction supports autonomy by allowing students

to ask questions and explore problems, competence through investigation and problem-solving, and relatedness through collaboration and interaction with peers and teachers. Satisfaction of these needs can strengthen students' motivation and engagement, thereby promoting interest, achievement, and retention in Biology.

The theories provide a complementary foundation for the study: Experiential Learning Theory explains how students learn through active experience, reflection, conceptualization, and application, while Self-Determination Theory explains why students become motivated and engaged in such learning experiences. Their combined perspective therefore supports the expected effectiveness of inquiry-based instructional strategy in improving students' interest, academic achievement, and retention in Biology.

Methodology

A quasi-experimental design was adopted for the study. The population comprised 88,721 students in 88 public senior secondary schools across the six Area Councils of the Federal Capital Territory (FCT), Abuja (FCT Secondary Education Board, 2025). A sample of 122 SS II students was selected from intact classes of 63 students in experimental group, while 59 students were in the control group. Data were collected using three instruments: Biology Interest Assessment Scale (BIAS), Biology Achievement Test (BAT), and Biology Retention Test (BRT). The BIAS contained 15 items on a four-point Likert scale, while the BAT and BRT each comprised 40 multiple-choice items. The instruments were validated by experts in Biology education. A pilot test involving 25 SS II students produced reliability coefficients of 0.86 for BIAS, 0.82 for BAT, and 0.79 for BRT, using Cronbach's alpha and KR-21, respectively.

The experimental group received six weeks of inquiry-based instruction involving questioning, exploration, investigation, experimentation, group discussion, analysis, and conclusion drawing, with the teacher serving as facilitator. The control group received conventional teacher-centred instruction involving direct teaching, explanations, textbook use, and teacher-led discussions. At the end of the intervention, BIAS and BAT were re-administered as posttests, while the BRT was administered two weeks later to assess retention. Data were analyzed using frequency, percentage, mean, and standard deviation to answer the research questions, while independent-samples *t*-test was used to test the hypotheses at the 0.05 level of significance.

Data Analysis and Results

The results are presented according to the research questions and corresponding hypotheses.

Table 1: Mean Interest Scores by Instructional Group

Group	n	Mean	SD	Mean Difference
Inquiry-based	63	46.11	3.52	7.72
Conventional	59	38.39	2.43	
Total	**122**			

Students exposed to inquiry-based instruction recorded a higher mean interest score (M = 46.11, SD = 3.52) than those taught using the conventional method (M = 38.39, SD = 2.43), with a mean difference of 7.72.

Table 2: Mean Academic Achievement Scores by Instructional Group

Group	n	Mean	SD	Mean Difference
Inquiry-based	63	73.56	3.86	14.87
Conventional	59	58.69	3.83	
Total	**122**			

The inquiry-based group obtained a higher achievement mean (M = 73.56, SD = 3.86) than the conventional group (M = 58.69, SD = 3.83), producing a mean difference of 14.87.

Table 3: Mean Retention Scores by Instructional Group

Group	n	Mean	SD	Mean Difference
Inquiry-based	63	64.90	2.80	14.15
Conventional	59	50.75	2.50	
Total	**122**			

Source: Research Field Survey (2025).

The inquiry-based group recorded a higher retention mean (M = 64.90, SD = 2.80) than the conventional group (M = 50.75, SD = 2.50), with a mean difference of 14.15.

Table 4: Interest Scores by Gender

Gender	n	Mean	SD	Mean Difference
Male	34	46.21	3.55	0.21
Female	29	46.00	3.56	
Total	**63**			

Within the inquiry-based group, male students recorded a mean interest score of 46.21 (SD = 3.55), while female students recorded 46.00 (SD = 3.56), giving a mean difference of 0.21.

Table 5: Academic Achievement Scores by Gender

Gender	n	Mean	SD	Mean Difference
Male	34	73.53	4.05	0.06
Female	29	73.59	3.69	
Total	**63**			

Table 5 shows that male students recorded a mean achievement score of 73.53 (SD = 4.05), while female students recorded 73.59 (SD = 3.69), representing a mean difference of 0.06.

Table 6: Retention Scores by Gender

Gender	n	Mean	SD	Mean Difference
Male	34	64.91	3.13	0.01
Female	29	64.90	2.43	
Total	**63**			

Table 6 shows that male students recorded a mean retention score of 64.91 (SD = 3.13), compared with 64.90 (SD = 2.43) for female students, giving a mean difference of 0.01.

Table 7: Summary of Hypothesis Testing

S/N	Hypothesis	*t*	df	*p*	Decision
1	Interest: Inquiry vs. conventional	13.99	120	.001	Rejected
2	Achievement: Inquiry vs. conventional	21.33	120	.001	Rejected
3	Retention: Inquiry vs. conventional	29.32	120	.001	Rejected
4	Interest: Male vs. female	0.23	61	.819	Not rejected
5	Achievement: Male vs. female	0.058	61	.954	Not rejected
6	Retention: Male vs. female	0.021	61	.983	Not rejected

Table 7 presents the summary of results of null hypothesis formulated for the study. For interest, the comparison between students taught using inquiry-based and conventional instructional strategies produced a *t*-value of 13.99 with 120 degrees of freedom and a *p*-value of 0.001. Since $p < 0.05$, the null hypothesis one was rejected. This indicates a statistically significant difference in students' interest between the two instructional groups, suggesting that inquiry-based instruction significantly enhanced students' interest in Biology compared with conventional instruction.

For academic achievement, the obtained *t*-value was 21.33 with 120 degrees of freedom and a *p*-value of 0.001. Since $p < 0.05$, the null hypothesis two was rejected. Thus, there was a statistically significant difference in achievement between students taught using inquiry-based and conventional instructional strategies, indicating that inquiry-based instruction significantly improved students' academic achievement in Biology. Similarly, the analysis of retention yielded a *t*-value of 29.32, 120 degrees of freedom, and a *p*-value of 0.001. The null hypothesis was therefore three rejected because $p < 0.05$. This demonstrates a statistically significant difference in retention between the two instructional groups, with inquiry-based instruction producing superior retention of Biology concepts. Regarding gender and interest, the obtained *t*-value of 0.23 with 61 degrees of freedom produced a *p*-value of 0.819. Since $p > 0.05$, the null hypothesis four was not rejected. Hence, there was no statistically significant difference between the interest scores of male and female students exposed to inquiry-based instruction. For academic achievement by gender, the result produced a *t*-value of 0.058, 61 degrees of freedom, and a *p*-value of 0.954. Since $p > 0.05$, the null hypothesis five was not rejected, indicating that male and female students did not differ significantly in academic achievement following exposure to inquiry-based instruction. Furthermore, the comparison of retention scores by gender yielded a *t*-value of 0.021 with 61 degrees of freedom and a *p*-value of 0.983. The null hypothesis six was not rejected because $p > 0.05$. This indicates that there was no statistically significant difference between male and female students' retention of Biology concepts.

Discussion of Findings

The findings showed that students taught Biology using the inquiry-based instructional strategy had significantly higher interest scores than those taught using the conventional method. This suggests that inquiry-based instruction enhances students' engagement by involving them in questioning, investigation, critical thinking, and problem-solving. The finding agrees with Ijeh (2020) and Dambana and Danjuma (2023), who reported significant effects of inquiry-based instruction on students' interest in Mathematics and Ecology, respectively.

The study also revealed a significant difference in academic achievement, with students exposed to inquiry-based instruction performing better than those taught conventionally. This may be attributed to the active involvement of learners in exploring problems, interpreting evidence, and constructing knowledge, which promotes deeper understanding of Biology concepts. The finding

is consistent with Adejo (2015), Mensah-Wonkyi and Adu (2016), Sylvanus and Eke (2017), Ibrahim et al. (2018), Issaka (2018), Azowenunebi et al. (2019), Annan et al. (2019), Ijeh (2020), Mwenda and Ndayambaje (2021), Danjuma and Mankilik (2022), Dushimimana and Mugabo (2022), Owolade et al. (2022), Olawuwo et al. (2024), Emmanuel et al. (2024), and James et al. (2024). However, it contrasts with Saba et al. (2019) and Chibueze and Okoye (2021), who reported no significant advantage of inquiry-based instruction over alternative approaches.

Similarly, students exposed to inquiry-based instruction demonstrated significantly better retention. This indicates that active investigation and meaningful engagement may facilitate durable learning by enabling students to connect new information with prior knowledge and repeatedly apply biological concepts. The finding agrees with Ibrahim et al. (2018), Issaka (2018), Ali et al. (2020), Enebechi (2021), Danjuma and Mankilik (2022), Olawuwo et al. (2024), and James et al. (2024), who reported significant effects of inquiry-based approaches on students' retention. However, Chibueze and Okoye (2021) reported that cooperative learning was more effective than inquiry learning in promoting retention.

With respect to gender, no significant difference was found between the interest scores of male and female students taught using inquiry-based instruction. This suggests that the strategy promotes students' interest without favouring either gender. The finding agrees with Ijeh (2020) and Dambana and Danjuma (2023), who similarly reported no gender disparity in students' interest following inquiry-based instruction.

The study further found no significant gender difference in academic achievement among students taught using inquiry-based instruction. This suggests that the strategy provides comparable learning opportunities for male and female students and that its effectiveness is not substantially dependent on gender. The finding is consistent with Adejo (2015), Ibrahim et al. (2018), Azowenunebi et al. (2019), Mkpa and Nwachukwu (2019), and Olawuwo et al. (2024). Conversely, Sylvanus and Eke (2017), Issaka (2018), and James et al. (2024) reported gender-related differences in achievement.

Furthermore, no significant difference was found between the retention scores of male and female students exposed to inquiry-based instruction. This indicates that inquiry-based instruction supports retention similarly among both genders. The finding agrees with Ibrahim et al. (2018), Ali et al. (2020), Enebechi (2021), and Olawuwo et al. (2024), but differs from Issaka (2018) and James et al. (2024), who reported significant gender-related differences in retention.

In general, the findings demonstrate that inquiry-based instructional strategy is more effective than conventional instruction in enhancing students' interest, academic achievement, and retention in Biology, while its effects on these outcomes appear not to differ significantly by gender. The consistency of most findings with previous studies strengthens the argument for greater use of inquiry-based instruction in senior secondary Biology classrooms in the Federal Capital Territory, Abuja.

Conclusion and Recommendations

In line with the findings of the study, it was concluded that inquiry-based instructional strategy significantly improves students' interest, academic achievement, and retention in Biology compared with conventional instruction. The strategy provides active, student-centred learning experiences that promote engagement, deeper understanding, and durable learning. Furthermore, the absence of significant gender differences in interest, achievement, and retention indicates that inquiry-based instruction is gender-inclusive and equally beneficial to male and female students. Therefore, the study recommends that:

i. Biology teachers should adopt inquiry-based instructional strategy more frequently to enhance students' interest, achievement, and retention.
ii. Teachers should receive regular training through workshops, seminars, and professional development programmes on effective implementation of inquiry-based instruction.
iii. Curriculum planners should incorporate inquiry-oriented activities, investigations, projects, and problem-solving tasks into the Biology curriculum.
iv. School administrators and policymakers should provide adequate instructional materials, laboratory resources, and supportive classroom environments necessary for effective inquiry-based teaching.
v. Since no significant gender differences were observed, teachers should provide equal opportunities for male and female students to participate in inquiry activities and ensure gender-inclusive classroom practices.
vi. Teachers should encourage students to ask questions, formulate hypotheses, investigate problems, analyse evidence, and communicate findings to strengthen critical thinking and independent learning skills.

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