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Relative Effects of Practical and Project Based Learning on Students' Interest in Biology in Aguata Education Zone

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Abstract
The study investigated effects of practical and project based learning on students' interest in Biology in Aguata Education zone of Anambra State, Nigeria. Two research questions and three hypotheses guided the study and relevant literatures were also reviewed. The study adopted quasi-experimental design. The population of the study comprised of 1098 SS 2 Biology students. The sample consisted of 105 SS2 students (57 males and 48 females). The sample was obtained using multi-stage sampling procedure. Academic Interest Scale for Adolescent adapted from Luo et al (2019) was used as instruments for data collection. The instrument was subjected to face and content validation. AISA reliability was established using Cronbach alpha and reliability coefficient yielded 0.74. Mean and Standard Deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The study revealed that students in the practical based learning group developed better interest than those taught the same Biology concept using project based learning. The study also observed that female students developed better interest than their male counterpart in the use of practical based learning in the Biology concepts taught. From the findings it was concluded that practical based learning boosts interest in Biology subject. Also, gender differences are nuanced, but no significant in gender instruction interactions. From the conclusions, implication was that stake holders should advocate for universal, equitable and varied instructional strategies.

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1. Introduction

The effectiveness of teaching methodologies in science education plays a pivotal role in shaping students' interest and engagement in different subjects. Within Biology education, the adoption of project-based and practical-based learning strategies has increasingly gained scholarly attention for their potential to enhance students' conceptual understanding, motivation, and long-term retention (Alane & Scottfield, 2022). Biology, as a core science subject in secondary education, remains indispensable in developing students' understanding of the living world and equipping them with scientific literacy necessary for addressing real life problems. It provides insight into the interactions of living and non-living components of the environment and the mechanisms that sustain life on earth.

According to Enebechi and Menkiti (2021), the Nigerian secondary school Biology curriculum aims to enable learners to apply scientific knowledge to everyday life, foster curiosity, and stimulate continued inquiry into natural phenomena. Biology's relevance extends to diverse fields such as medicine, biotechnology, genetics, and environmental science. Advances in biological research have contributed to significant innovations including improved disease treatments, sustainable agriculture, and ecological conservation (Mohammed, 2019). Though Biology is commonly divided into Botany and Zoology, it encompasses many specialized areas such as microbiology, biochemistry, and biotechnology, often integrating with disciplines like engineering and mathematics (Alane & Scottfield, 2022). This interdisciplinary nature highlights the need for innovative pedagogies that make Biology learning relevant and stimulating.

The National Policy on Education (FRN, 2013) emphasizes the development of scientific knowledge and practical skills through Biology education. This includes laboratory and fieldwork experiences that prepare students for productive participation in national development. Achieving these goals requires instructional strategies that foster active learning particularly practical-based and project-based methods, which have proven effective in enhancing learners' interest and participation. Despite Biology no longer being compulsory for all senior secondary students, interest in the subject remains relatively high even among non-science students (Matazu & Isma'il, 2024). However, ensuring sustained student interest is essential for promoting meaningful learning outcomes.

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Interest is a critical affective variable influencing students' motivation and engagement in learning (Ashley, Eva, Sarah, & Lisa, 2019). It reflects a student's desire, curiosity, and willingness to devote effort toward a subject. In the educational context, it manifests as sustained attention and commitment to academic tasks (Ibenegbu, Nzewi, & Aniaku, 2020). Without interest, effective learning is difficult to achieve. Students who develop genuine interest in Biology are more likely to persist, explore, and develop deep conceptual understanding. Enebechi (2016) stressed that using appropriate instructional strategies and teaching aids enhances students' enthusiasm toward Biology, counteracting perceptions that the subject is abstract or difficult. Similarly, Harackiewicz, Smith, and Priniski (2016) noted that interest is a powerful motivator that drives learning and influences academic and career pathways. Adekunle and Femi-Adeoye (2016) further asserted that interest arises from curiosity and attention; without these, students may find Biology overwhelming and disengaging. To promote interest, Biology instruction should integrate experiential learning strategies such as hands-on practicals and project-based activities that encourage students to construct knowledge through active participation. Project-based learning (PBL) is a learner-centered approach where students investigate real-world problems collaboratively to produce meaningful outcomes. According to Amadi (2016), PBL enables learners to enjoy and find relevance in tasks, thereby fostering motivation and sustained engagement. The method offers multiple opportunities for hands-on exploration, teamwork, and problem-solving, which in turn strengthen students' interest in scientific inquiry.

Ulya (2022) described project-based learning as a problem-focused and collaborative instructional approach where students assume active roles while teachers facilitate learning. This method emphasizes application over memorization, encouraging autonomy, critical thinking, and creativity. Silas (2021) argued that PBL enhances learners' motivation and self-confidence as they acquire and apply knowledge to solve authentic problems. Outi and Maija (2021) similarly observed that PBL strengthens teacher–student collaboration and helps students understand the logical processes involved in inquiry. Ibragimov (2021) described project-based learning as a form of self-directed study that enhances problem-solving abilities and stimulates sustained interest in learning. Thus, PBL provides opportunities for students to connect theory with practice, making Biology education more engaging and meaningful.

In addition to project work, the practical method remains integral to Biology instruction. Practical activities expose learners to direct observation and experimentation, fostering better understanding of biological phenomena. Niyitanga, Bihoyiki, and Nkundabakura (2021) affirmed that practical teaching promotes knowledge transfer and skill acquisition, enabling students to relate classroom learning to their environment. Practical work involves active manipulation of real objects, materials, and living organisms, thereby strengthening psychomotor and cognitive skills. Omeodu (2018) emphasized that practical work enhances learners' competencies, supports technological development, and promotes social interaction during learning. When learners engage in experimentation, they tend to achieve better retention, satisfaction, and performance outcomes compared to those taught with theoretical methods.

Hamisu (2017) observed that hands-on learning allows students to progress from handling concrete objects to representing them with diagrams and abstract symbols. This process fosters deeper conceptual understanding and cognitive development. Practical learning, whether conducted in the laboratory or through fieldwork, nurtures curiosity, reinforces interest, and develops essential scientific attitudes. Consequently, combining project-based and practical-based learning methods can significantly enhance students' motivation and sustained interest in Biology.

Another factor influencing interest is gender. The World Health Organization defines gender as the socially constructed roles, behaviors, and attributes considered appropriate for men and women. Gender has long been recognized as a significant variable in educational research, often linked to disparities in participation and achievement in science-related subjects. Muokwe (2021) noted that gender bias continues to exist in Nigerian classrooms, with female students often perceiving practical and project tasks as male-oriented activities. Such stereotypes can diminish their confidence and interest in science learning. Therefore, Biology instruction should be inclusive, providing equal opportunities for both male and female students to engage collaboratively in hands-on and project-based tasks. Teachers must consciously eliminate gendered task assignments to foster equitable learning experiences and ensure that both genders benefit from the same scientific exposure and encouragement.

In sum, fostering students' interest in Biology requires integrating learner-centered pedagogies such as practical and project-based learning. These methods enable students to explore real-world problems, apply scientific reasoning, and engage collaboratively, thereby making learning more interactive and meaningful. By reducing gender bias and promoting equal participation, teachers can further sustain students' enthusiasm for Biology. Hence, this study examines the effects of practical and project-based learning on students' interest in Biology in Aguata Education Zone, with the goal of identifying effective strategies to enhance student engagement and interest in Biology education.

1.1. Statement of the Problem

Non-science students show a great deal of interest in Biology despite the fact that Biology is no longer a core compulsory science subject at the senior secondary school level. It is central to the acquisition of knowledge and skills that prepare learners for careers in medicine, pharmacy, agriculture, biotechnology, and other science-related fields. Despite its importance, the teaching and learning of Biology in Nigeria, particularly in Aguata Education Zone, have continued to face challenges. Reports from WAEC and other examination bodies indicate persistent poor performance and low interest among students offering Biology. Many students perceive Biology as abstract and difficult to understand, largely because classroom instruction often emphasizes rote learning and theoretical explanations with little or no practical or project-based engagement. Interest plays a crucial role in sustaining students' motivation and achievement in Biology. When students are not actively engaged in the learning process through practical and hands-on experiences, their curiosity and enthusiasm tend to decline. Traditional teacher-centered approaches, which are still dominant in many schools in Aguata Education Zone, often fail to provide opportunities for learners to explore, experiment, and apply concepts to real-life situations. Consequently, students lose interest in Biology, leading to low enrollment in science-related courses and poor performance in external examinations.

Research evidence suggests that practical activities and project-based learning strategies enhance learners' involvement, stimulate curiosity, and promote long-term interest in science subjects. However, in many secondary schools in Aguata Education Zone, the extent to which practical and project-based learning is utilized to improve students' interest in Biology remains uncertain. There is therefore a need to empirically investigate whether practical and project-based learning approaches can significantly influence students' interest in Biology.

This study, therefore, sought to examine effects of practical and project-based learning on students' interest in Biology in Aguata Education Zone.

1.2. Purpose of the Study

The main purpose of the study is to examine effects of practical and project based learning approaches on students' interest in Biology in Aguata Education Zone. This study aims to assess whether these interactive learning methods can increase students' interest in Biology as compared to mere conventional methods. Specifically, the study sought to determine the:

a. Mean interest scores of students when exposed to practical and project based learning in Biology in Aguata Education Zone.

b. Mean interest scores of male and female students when taught Biology using practical and project-based learning in Aguata Education Zone.

c. Interaction effect of gender and instructional strategies on the mean interest scores of students in Biology.

1.3. Scope of the Study

The study investigated effects of project and practical based learning on students' interest in Biology in Aguata Education Zone of Anambra State. The study was delimited to SS II Biology students. The content scope for the study covered; reproductive systems in vertebrates and reproductive system in flowering plants. These topics though look like two but are very vast to be covered within 4 weeks and they yielded themselves to both practical and project methods.

1.4. Research Questions

The study sought to find answers to the following research questions:

a. What are the mean interest scores of students exposed to practical and project based learning in Biology in Aguata Education Zone?

b. What are the mean interest scores of male and female students in Biology when taught using practical and project based learning in Aguata Education Zone?

1.5. Hypotheses

The following hypotheses were formulated for the study and they were tested at 0.05 level of significance.

a. There is no significant difference in the mean interest scores of students exposed to practical and project based learning in Biology.

b. There is no significantt difference in the mean interest scores of male and female students when taught Biology using practical and project based learning.

c. There is no significant interaction effect of gender and instructional strategies on the mean interest scores of students in Biology.

2. Method

The study employed a quasi-experimental pre-test, post-test design (non-randomized, non-control group). According to Nworgu (2015), this design determines the effect of a treatment on a non-randomized sample, often used when random assignment is impractical. Thus, intact classes were assigned to experimental groups. The study was conducted in Aguata Education Zone of Anambra State, with a population of 1,098 SS II Biology students (546 males and 552 females) obtained from the PPSSC Statistics Department. SS II students were chosen because their scheme of work contained the relevant topics, they had prior exposure to practical and project activities in SS I, and were not yet preparing for external examinations. A total of 105 students (57 males and 48 females) formed the sample, selected through a multi-stage sampling procedure. First, two Local Government Areas were chosen by simple random sampling from the three in the zone. Second, 26 co-educational schools were purposively selected to ensure gender balance. Third, one school from each selected LGA was randomly assigned to Experimental Group 1 (Practical-Based Learning) and Experimental Group 2 (Project-Based Learning). Finally, one intact SS II class was chosen in each school by balloting. Experimental Group 1 had 48 students (26 males, 22 females), while Group 2 had 57 students (31 males, 26 females), giving a total of 105 participants.

2.1. Instrument for Data Collection

The instrument used for data collection was the Academic Interest Scale for Adolescents (AISA), adapted from Luo et al. (2019) and modified by the researcher to fit the study context. AISA is a multidimensional tool designed to measure students' academic interest across school subjects, based on Hidi and Renninger's four-phase interest development model. The instrument contains 29 items structured on a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). High scores indicate strong academic interest, while low scores indicate weak or no interest.

2.2. Validation of the Instrument

The AISA was subjected to face and content validation by three experts two from the Department of Science Education and one from the Measurement and Evaluation Unit, Department of Educational Foundations, Nnamdi Azikiwe University, Awka. Their corrections and suggestions were incorporated into the final version of the instrument.

2.3. Reliability of the Instruments

Reliability was determined through a pilot test involving 30 SS II Biology students from Akaboezem Community Secondary School, Nnewi, outside the study area. The Cronbach Alpha method yielded an internal consistency coefficient of 0.74, indicating good reliability for the instrument.

2.4. Experimental Procedure

Permission was obtained from school principals before the study commenced. Biology teachers were briefed and assisted in administering the pre-test (AISA). During treatment, the researcher made unannounced visits to ensure fidelity. After the intervention, a post-test with reshuffled items was administered, and Biology teachers marked the scripts. The researcher collected and collated all scores for analysis.

2.5. Method of Data Analysis

Data were analyzed using Mean and Standard Deviation to answer the research questions, while Analysis of Covariance (ANCOVA) tested the hypothesis at a 0.05 significance level. The decision rule stated that if $p \leq 0.05$, the null hypothesis was rejected; otherwise, it was retained.

3. Results and Discussion

Data collected were analyzed and presented in tables according to research questions and hypotheses as follows:

3.1. Research Question 1: What are the Mean Interest Scores of Students Exposed to Practical and Project Based Learning in Biology in Aguata Education Zone?

Table 1 presents the pretest and posttest interest scores of students taught Biology through practical and project-based learning. The pretest mean scores were 96.04 and 88.89 with standard deviations of 7.45 and 19.94, respectively, while the posttest means were 108.35 and 107.84 with standard deviations of 5.42 and 5.04. The lower posttest standard deviations indicate reduced variability in students' scores after treatment. Both groups recorded higher posttest means, suggesting improved interest in Biology. However, students exposed to practical-based learning achieved a greater mean gain (12.31) compared to those in project-based learning (18.95), implying that practical activities more effectively enhanced students' interest in Biology.

Table 1. Mean and Standard Deviation Interest Scores of Students Exposed to Practical and Project Based Learning in Biology

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Practical	48	96.04	7.45	108.35	5.42	12.31
Project	57	88.89	19.94	107.84	5.04	18.95

3.2. Research Question 2: What are the Mean Interest Scores of Male and Female Students in Biology When Taught Using Practical and Project Based Learning in Aguata Education Zone?

Table 2 presents the mean and standard deviation of male and female students' interest scores under practical- and project-based learning conditions. For practical-based learning, male students recorded pretest and posttest means of 96.12 and 107.13 (SD = 8.00, 5.43) with a mean gain of 11.52, while females scored 95.96 and 109.13 (SD = 6.99, 5.42) with a mean gain of 13.17. Similarly, in project-based learning, male students had means of 88.10 and 107.68 (SD = 18.43, 5.29) with a gain of 19.58, and females scored 89.85 and 108.04 (SD = 21.94, 4.84) with a gain of 18.19. Lower posttest standard deviations indicate reduced score variability after treatment. Across both strategies, female students consistently achieved higher posttest means than their male counterparts, indicating greater interest in Biology. Overall, females taught through practical-based learning demonstrated the highest interest (M = 109.13), followed by females in project-based learning (M = 108.04), males in project-based learning (M = 107.68), and males in practical-based learning (M = 107.13).

Table 2. Mean and Standard Deviation Interest Scores of Male and Female Students Exposed to Practical and Project Based Learning in Biology

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Practical	48					
Male	26	96.12	8.00	107.64	5.43	11.52
Female	22	95.96	6.99	109.13	5.42	13.17
Project	57					
Male	31	88.10	18.43	107.68	5.29	19.58
Female	26	89.85	21.94	108.04	4.84	18.19

3.3. Hypothesis 1: There is No Significant Difference in the Mean Interest Scores of Students Exposed to Practical and Project Based Learning in Biology

Table 3 indicates a significant difference in students' mean interest scores between those taught Biology through practical and project-based learning, $F(1, 1327.240) = 5.44$, $p = 0.022$. Since the p-value is below the 0.05 significance level, the null hypothesis is rejected. This finding suggests that the teaching methods produced significantly different effects on students' interest in Biology, with practical-based learning yielding higher interest scores.

Table 3. Analysis of Covariance (ANCOVA) of Students' Mean Interest Scores between Practical and Project Based Learning in Biology

Source of Variation	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	1330.982[a]	2	665.491	2.728	.070	NS
Intercept	2040.763	1	2040.763	8.365	.005	S
Posttest (Covariate)	.019	1	.019	.000	.993	NS
Learning Strategy (Practical vs Project-Based)	1327.240	1	1327.240	5.441	.022	S
Error	24883.266	102	243.954			
Total	918065.000	105				
Corrected Total	26214.248	104				

[a] R Squared = .051 (Adjusted R Squared = .032)
Decision rule: Significant (S) if p < .05; Not Significant (NS) if p ≥ .05
Alpha level = .05

3.4. Hypothesis 2: There is No Significant Difference in the Mean Interest Scores of Male and Female Students when Taught Biology using Practical and Project Based Learning

The results in Table 4 reveals that significant difference in the mean interest scores of male and female students when taught Biology using practical and project based learning, F(1,187.121) =0.733, p = 0 .394. Since the obtained p-value is greater than the stipulated 0.05 level of significance, the null hypothesis which stated that there is no significant difference in the mean interest scores of male and female students when taught Biology using practical and project based learning is uphold. This implies that there is no significant difference in the mean interest scores of male and female students in when taught Biology using practical and project based learning.

Table 4. Analysis of Covariance (ANCOVA) of Male and Female Students' Mean Interest Scores between Practical and Project Based Learning in Biology

Source of Variation	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	190.862[a]	2	95.431	.374	.689	NS
Intercept	1932.708	1	1932.708	7.575	.007	S
Posttest (Covariate)	1.584	1	1.584	.006	.937	NS
Gender (Practical vs Project-Based)	187.121	1	187.121	.733	.394	NS
Error	26023.385	102	255.131			
Total	918065.000	105				
Corrected Total	26214.248	104				

[a] R Squared = .007 (Adjusted R Squared = −.012)
Decision rule: Significant (S) if p < .05; Not Significant (NS) if p ≥ .05
Alpha level = .05

3.5. Hypothesis 3: There is No Significant Interaction Effect of Gender and Instructional Strategies on the Mean Interest Scores of Students in Biology

The results displayed in Table 5 shows that there is no significant interaction effect of gender and instructional strategies (practical and project based) on the mean interest scores of students in Biology, F (1, 26.844) =0.109 *p*= 0.742. Since the obtained p-value of 0.742 is greater than the stipulate 0.05 significance level, the null hypothesis which stated that there is no significant interaction effect of gender and instructional strategies on the mean interest scores of students in Biology is thereby uphold. This implies that the instructional strategies (practical and project based) has equal effect on male and female students' interest in Biology concepts taught. The graph of no interaction is shown in Figure 1.

Table 5. Analysis of Covariance (ANCOVA) of the Learning Strategies and Gender Interaction on Pretest and Posttest Interest Mean Scores in Biology

Source of Variation	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	1545.177[a]	4	386.294	1.566		
Intercept	2108.286	1	2108.286	8.546		
Posttest (Covariate)	.380	1	.380	.002	.969	NS
Gender	198.318	1	198.318	.804		NS
Instructional Strategy (Practical vs Project-Based)	1350.201	1	1350.201	5.473		S
Gender × Instructional Strategy	26.844	1	26.844	.109	.742	NS
Error	24669.071	100	246.691			
Total	918065.000	105				
Corrected Total	26214.248	104				

[a] R Squared = .059 (Adjusted R Squared = .021)
Decision rule: Significant (S) if p < .05; Not Significant (NS) if p ≥ .05
Alpha level = .05

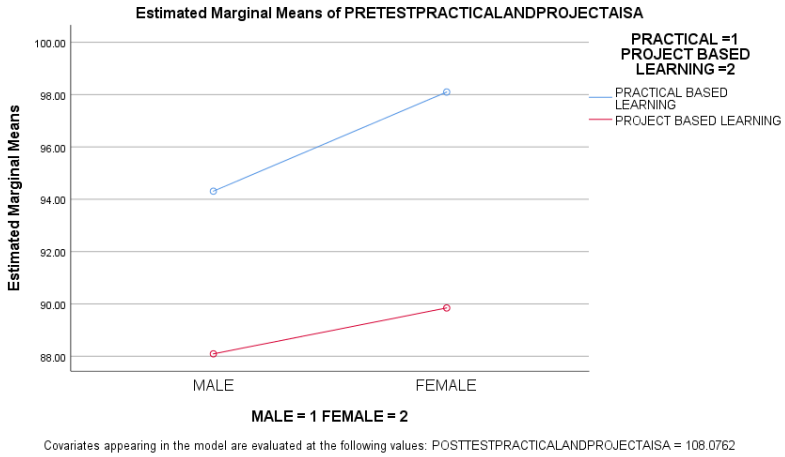

Figure 1. Profile Plots of the Interaction Effect of Gender and Instructional Strategies (Practical and Project Based) on the Mean Interest Scores of Students in Biology

3.6. Discussion

The study revealed that students taught Biology through practical-based learning developed greater interest than those taught with project-based learning (Table 1). This aligns with Enebechi (2023), who found that instructional media enhanced students' Biology interest, and with previous findings that practical activities promote engagement and motivation (Nebo, Obodo & Asogwa, 2023; Onu, Anyaegbunam & Uzoigwe, 2020; Wekesa & Ongunya, 2016). The higher interest from practical-based learning may stem from its hands-on nature, immediate feedback, and tangible outcomes, which sustain curiosity more effectively than the delayed results common in project-based learning.

A significant difference in students' mean interest scores between both strategies was also observed (Table 3), favouring practical-based learning. This supports Ibenegbu, Nzewi, and Aniaku (2020), who reported improved interest when Biology was taught through practical and blended methods. Practical activities likely encourage active participation and instant reinforcement, enhancing intrinsic motivation.

Findings further indicated that female students showed higher interest than males (Table 2). This contrasts with Ibenegbu et al. (2020) and Anidu and Udoh (2021), who found no gender-based difference in Biology interest, but agrees with Ihejiamazu, Obi, and Neji (2020), who reported gender influence on students' Biology interest and performance.

However, no significant difference was found between male and female students when taught using either practical or project-based learning (Table 4). This agrees with Nwuba, Egwu, Awosika, and Osuafor (2023), who reported no gender influence, but differs from Amedu (2015) and Jia, Yang, Qian, and Wu (2020), who found gender-related variations in science interest. The absence of significant difference may indicate that both instructional methods equally engage students regardless of gender.

Similarly, no significant interaction effect was found between gender and instructional strategies (Table 5), suggesting that both approaches affected male and female students uniformly. This aligns with the reports of Abidoye (2017) and Nwuba et al. (2023), but contrasts with Onu, Anyaegbunam, and Uzoigwe (2020), who observed a significant interaction. The result implies that both genders benefited equally due to similar levels of engagement and scaffolding.

In summary, practical-based learning proved more effective in enhancing students' interest in Biology than project-based learning. Female students demonstrated slightly higher interest, though gender and instructional methods showed no significant interaction effect.

3.7. Recommendations

Based on the findings of the study it is recommended that:

a. All stake holders should prioritize practical-based learning (PBL) for Biology instruction and other science instructions in science subjects.

b. Teachers should adopt a blended approach that leverages strengths of both methods.

c. Curriculum planers and instructors should always collect data on interest to detect shifts and adjust instructional mix accordingly when need be.

d. Authorities should always involve students in designing inquiries or choosing project contexts to sustain interest and motivation.

4. Conclusion

This study examined the effects of practical-based and project-based learning on senior secondary school students' interest in Biology in Aguata Education Zone of Anambra State. Based on the findings, it is concluded that both instructional strategies enhanced students' interest in Biology; however, practical-based learning proved more effective than project-based learning in stimulating and sustaining students' interest. The hands-on, experiential nature of practical activities appears to provide immediate engagement and concrete learning experiences that foster curiosity and sustained attention among learners. Furthermore, the study revealed that female students recorded slightly higher interest scores than their male counterparts across both instructional strategies. Nonetheless, this observed difference was not statistically significant, indicating that both male and female students benefited comparably from practical-based and project-based learning approaches. Similarly, the absence of a significant interaction effect between gender and instructional strategies suggests that the effectiveness of these learner-centered methods is not dependent on students' gender. Overall, the findings underscore the importance of adopting activity-oriented instructional strategies in Biology classrooms. Practical-based learning, in particular, emerges as a powerful pedagogical approach for enhancing students' interest in Biology, while project-based learning remains a valuable complementary strategy. The study therefore affirms that when Biology instruction is experiential, inclusive, and learner-centered, students' interest can be significantly improved, regardless of gender differences.

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All authors have equal contributions to the paper. All the authors have read and approved the final manuscript

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Declaration of Conflicting Interests

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Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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