



Comparative Effect of Flipped Classroom and Project-based Instructional Strategies on Senior Secondary School Students' Attitude and Engagement in Drawing Biological Diagrams

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Abstract

The study investigates the impact of flipped classroom and project-based instruction on secondary school students' attitudes and engagement in drawing biological diagrams within Nsukka Education Zone of Enugu State. Guided by two research questions and null hypotheses, it utilized a co-relational design. The research used 1,778 Senior Secondary School two Biology students from 62 schools in the zone, with a sample of 81 students from two intact classes. Data was collected using two instruments: the Attitude towards Biological Drawing Questionnaire (AtBDQ) and the Engagement in Biological Drawing Questionnaire (EiBDQ). The reliability coefficient was 0.85 and 0.82. The data were analyzed using mean, standard deviation, and analysis of covariance (ANCOVA). Results showed that students taught using the project-based instruction showed a more positive attitude towards drawing biological diagrams than those taught using the flipped classroom method, it showed that flipped classroom and project-based instruction do not differ significantly in their effects on students' attitude towards drawing biological diagrams. Project-based instruction was more effective, on students' engagement in drawing biological diagrams. The study suggested that educators integrate these methods to enhance students' attitudes, and participation in science task.

Keywords: Attitude, Engagement, Flipped Classroom and Project based instructional strategies.

Introduction

Drawing biological diagrams enhances understanding of complex concepts. However many Nigerian secondary school students show negative attitudes and low engagement in drawing them. This hinders their understanding, retention and achievement in biology. Previous studies attribute this to factors like traditional teaching methods and students lack of confidence in drawing. Innovative instructional strategies, like Flipped Classroom and Project-Based Learning (PBL), show promise in improving student attitudes and engagement through interactive methods. These methods encourage active participation, skill development, and knowledge application. However, there is limited empirical evidence on their effectiveness in improving attitudes and engagement. Therefore, the need to investigate the effects of Flipped Classroom and Project-Based Instructional Strategies on secondary school students' attitudes and engagement in drawing biological diagrams.

Biology studies living organisms and diverse life forms on Earth, including humans. It examines

organism function, interaction, and evolution. In Nigeria, biology is a key subject in secondary schools and universities, serving as a foundation for professions such as medicine, nursing, pharmacy, forestry, fisheries, and other life science-related disciplines (Adebayo & Oladele, 2016). Biology importance transcends boundaries, impacting human health, conservation, and our understanding of life. However empirical evidence points to challenges despite its importance to a widespread of negative attitude among secondary school students towards drawing biological diagrams, a crucial aspect of learning biology.

Biological diagrams are vital tools for studying biology, because they visually represent complex structures and processes, making them easier for students to understand. These diagrams are crucial for illustrating the intricate details of biological phenomena, such as the anatomy of organisms, cellular structures, and physiological processes, thereby improving learning experience (Manning &



Nobes, 2017; Wilson & Butcher, 2020). Their significance lies in their ability to translate abstract concepts into tangible visuals that can be more easily understood and remembered.

Research indicates that students often struggle with drawing and interpreting these diagrams, leading to misconceptions and a lack of confidence in their ability to accurately represent biological structures and processes (Manning & Nobes, 2017). This challenge is intensified by insufficient training many students receive which are necessary skills required for biological diagrams, resulting in a gap in their overall understanding of biology (Wilson & Butcher, 2020). As a result, many students in recent years exhibit unfavorable or negative attitude towards the subject.

Attitude is an important factor in learning and understanding Biology. Attitude is an evaluative reaction expressed in one's beliefs, feelings, or intended behaviour, (Clayton and Myers, 2015). It is referred to as the tendency to perform or respond positively or negatively to specific situations and ideas (Issa, Bashorun, Mubashir, & Adewusi, 2010). That is, individuals show positive or negative inclinations towards certain people, object and activities. In the classroom, attitudes are structures of assessment, emotions, and dispositions, Usman, Yew, & Saleh, (2018).

Empirical reports on students' negative attitudes toward biology, is evident in literature. For instance, Ogunleye and Adesina (2020) revealed that a significant number of students demonstrated a negative attitude towards drawing biological diagrams. Ibrahim and Mohammed (2024) in a study also reported high level of students' reluctance towards engaging in drawing activities in Biology. Likewise, Bassey and Etim (2024) also revealed students' negative attitudes towards Biology, which is associated with biological diagrams.

In an earlier study by Adeyemi and Olatunji (2021), they reported that students' negative attitudes towards drawing biological diagrams were linked to inadequate instructional support. Nwafor and Eze (2022) also stated that students' poor attitude towards drawing biological diagrams was associated with a lack of confidence in their artistic abilities. However, Ajayi and Abimbola (2024) observed that the instructional methods used by teachers played a significant role in students' negative attitude towards biological drawings. The lack of interactive and participatory learning experiences made students view drawing as a tedious

and irrelevant activity, negatively affecting their engagement in this aspect of Biology.

Engagement is a crucial factor in the learning and understanding of biology. It is the level of interest, motivation, and involvement that students demonstrate in the learning process (Holmes, 2023). Engagement in education involves the behavioral, emotional, and cognitive investment that students make in their academic activities, reflecting their active participation and dedication to the learning process (Willms, Friesen, & Milton, 2022).

In the learning of biology, student engagement plays a vital role in how students interact with the subject matter, including their involvement in practical activities, attention to theoretical concepts, and willingness to engage in problem-solving tasks (Sinatra, Heddy, & Lombardi, 2023). Engaged students are more likely to exhibit curiosity, ask questions, and explore biological concepts beyond the classroom, leading to a deeper understanding of the subject (Fredricks et al., 2021). On the other hand, a lack of engagement can result in superficial learning, where students may struggle to grasp complex biological ideas or apply their knowledge effectively in real-world contexts (Holmes, 2023).

Studies highlights varying levels of student engagement in biology, particularly concerning drawing biological diagrams. Ogunleye and Adesina (2022) reported that many students exhibited low engagement in drawing biological diagrams, perceiving the activity as tedious and challenging. Ibrahim and Mohammed (2024) found a general reluctance among students to engage in drawing activities in biology, noting that students often avoided these tasks due to perceived difficulty and time constraints. Bassey and Etim (2024) also documented low engagement levels among students in drawing biological diagrams, linking this to students' perception that these diagrams were not crucial for passing exams.

Lack of engagement by students can negatively impact their overall understanding of biology, as drawing diagrams is a key skill that aids students in visualizing and internalizing complex biological concepts. To enhance engagement in biological drawings, it is essential to incorporate a more interactive and student-centered instructional strategy that emphasize the importance of these activities in understanding biological concepts (Ibrahim & Mohammed, 2024). Two interactive student-centered instructional strategies that could be anticipated to promote students' attitude towards biological drawing

and engagement in this area are the flipped classroom and project-based instructional strategies

The Flipped Classroom model, which inverts the traditional learning environment by delivering instructional content outside the classroom and using classroom time for active learning, has gained considerable attention in recent years. This model allows students to learn at their own pace and provides more opportunities for hands-on activities during class time, which can be particularly beneficial in subjects like biology that require a high level of cognitive engagement and skill acquisition (Bishop & Verleger, 2019). Recent studies have demonstrated that the Flipped Classroom approach not only improves students' understanding of scientific concepts but also positively influences their attitudes toward the subject (Chen et al., 2022; Zainuddin & Attaran, 2020). Hence the need to investigate the effect of flipped classroom, not only on attitude but also on engagement in drawing biological terms.

Project-Based Learning (PBL), on the other hand, emphasizes active exploration of real-world challenges and problems, encouraging students to take ownership of their learning. In the context of biology, PBL has been shown to enhance students' engagement by allowing them to apply theoretical knowledge in practical, often collaborative, projects (Bell, 2019). This approach aligns well with the demands of modern education, where students are expected to develop not just content knowledge but also critical thinking, creativity, and problem-solving skills (Thomas, 2021). Recent research indicates that PBL can significantly improve students' attitudes towards science subjects by making learning more relevant and enjoyable (Capraro & Slough, 2021; Kokotsaki et al., 2019). Hence the need to investigate the effect of PBL on students attitude and engagement in drawing biological diagram.

Drawing biological diagrams is a fundamental skill in biology, but traditional teaching methods often disengage students. Integrating flipped classroom and PBL strategies could create a more effective, student-centered learning environment.

Research Questions:

1. What are the mean attitude scores of students taught drawing of biological diagrams using flipped classroom instructional strategy and those taught drawing of biological diagrams using project-based instructional strategy?

2. What are the mean engagement scores of students taught drawing of biological diagrams using flipped classroom instructional strategy and those taught drawing of biological diagrams using project-based instructional strategy?

Hypotheses

The following null hypotheses guided the study was tested at 0.05 levels of significance:

HO₁: There is no significant effect of flipped classroom and project-based instructional strategies on students 'mean attitude score towards drawing biological diagrams.

HO₂: There is no significant effect of flipped classroom and project-based instructional strategies on students 'mean engagement score in drawing biological diagrams.

Methodology

Design

The study adopted a quasi-experimental approach, utilizing a non-equivalent pretest-posttest control group design. Two intact classes were selected for the research, This design allowed the researcher to apply and observe the effects of two different instructional strategies, flipped classroom and project-based learning, on separate groups at the same time.

The study was conducted in the Nsukka Education Zone of Enugu State, which consists of 62 public secondary schools and a total of 1,778 Senior Secondary Two (SS2) students. The sample for the study comprised students from two intact SS2 biology classes drawn from the zone. A multistage sampling method was employed to select the participants. In the first stage, one local government area (LGA) was randomly selected from the three LGAs in the zone using a simple random sampling technique (balloting without replacement). From each of these schools, one intact SS2 class offering biology was randomly selected. Each of the selected classes was assigned to a different instructional approach—one group received lessons using the flipped classroom method, while the other was taught using the project-based strategy. The total number of 81 students in both intact classes formed the sample size for the study.

The instruments used for collecting data in this study were the Attitude towards Biological Drawing Questionnaire (AtBDQ) and the Engagement in Biological Drawing Questionnaire (EiBDQ). Both instruments were structured into two sections: A and B

.Section A of the AtBDQ gathers demographic and background information from the respondents, while Section B consists of 15 items aimed at assessing students' attitudes toward biological drawings. Participants were asked to indicate their level of agreement with each item using a four-point Likert scale with the options: Strongly Agree (SA), Agree (A), Disagree (DA), and Strongly Disagree (SD). These options were scored as 4, 3, 2, and 1 respectively for positively worded items, and the scoring was reversed for negatively worded items. Similarly, the EiBDQ follows the same structure. Section A captures personal information, while Section B includes 15 items that explore the level of students' involvement and engagement in biological drawing activities. Responses are also rated using the same four-point Likert scale format, with appropriate scoring for both positive and negative statements. The maximum score is 4 and the minimum 1.

To determine the reliability of the instruments, Cronbach Alpha method was used and reliability coefficients of 0.85 for the AtBDQ and 0.82 for the EiBDQ, was gotten.

Experimental Procedure

The experiment lasted for 6 weeks. 3-day training was organized for the Biology teachers from

sampled schools. Week 1, involved biology teacher training. In week 2, research assistants gave pre-test AtBDQ and EiBDQ to intact classes before the lesson begins. In week 3, the instructional phase began, with the teachers conducting the experiments. Students were organized in two respective groups (Flipped Classroom and Project-Based Instructional Strategies). At the end of the experiments which ran concurrently, research assistants used the same lesson plans but different instructional strategies (Flipped classroom for group one and Project-based for group two). The post-test was administered after the experiment at the end of the 6th week using the same instruments reshuffled. Students scores from pretest and posttest for both groups was used for data analysis.

Method of Data Analysis

The AtBDQ and EiBDQ copies were reviewed for complete responses before data analysis. IBM's SPSS version 26 was used. Descriptive statistic (mean and standard deviation) answered research questions. ANCOVA tested the null hypotheses, with the significance level set at 0.05. Hypothesis with P- value below 0.05 will be rejected; those with P- value above 0.05 will not be rejected.

Result

The results were presented in line with the research questions and the null hypotheses that guided the study.

Table 1: Pretest and posttest mean effects of flipped classroom and project-based instructional strategies on students' attitude towards drawing biological diagrams

Instructional Strategies	Pre-test			Post-test		
	N	\bar{X}	SD	\bar{X}	SD	Mean Difference
Flipped Classroom	42	34.26	4.61	45.02	5.80	10.76
Project-Based	39	34.23	5.04	45.62	6.43	11.39

Note: N = Number of Respondents, \bar{X} = Mean, SD = Standard deviation

Table 1 presents students' attitude scores before and after instruction using the two methods. The flipped classroom group average score improved from, pretest of 34.26 (SD = 4.61) to 45.02 (SD = 5.80) at posttest, while the project-based group score increased from pretest of 34.23 (SD = 5.04), to 45.62 (SD = 6.43) at posttest. This reflects a mean difference of 10.76 for the flipped classroom group and 11.39 for the project-

based group. This indicates a positive shift in attitude, with the project-based strategy showing slightly higher improvement. This implies that although both flipped classroom and project-based instructional strategies effectively promote students' attitude towards drawing of biological diagrams, the project-based instructional strategy appears more effective.

Hypothesis One

Table 2: Analysis of covariance (ANCOVA) of the difference in the effects of flipped classroom and project-based instructional strategies on students' attitude towards drawing biological diagrams

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared (η^2_p)	Dec.
Corrected Model	1285.175 ^a	4	321.294	14.638	.000	.435	
Intercept	8099.794	1	8099.794	369.031	.000	.829	
PretestAtBDDScores	1252.721	1	1252.721	57.075	.000	.429	
Groups	8.907	1	8.907	.406	.526	.005	NS
Error	1668.109	76	21.949				
Total	169236.000	81					
Corrected Total	2953.284	80					

Note: df= Degree of Freedom, F= F-ratio, Sig.= Significant/probability value, Dec.= Decision, NS = NotSignificant, S = Significant

Table 2 indicates no statistically significant difference between the flipped classroom and project-based instruction in impacting students' attitudes toward drawing biological diagrams, ($F(1, 81) = 0.406$, $p = 0.526$, $\eta^2_p = 0.005$). The p-value of 0.526 exceeds the 0.05 significance threshold, implying the observed variation is not meaningful. The partial eta squared

value ($\eta^2_p = 0.005$) suggests that only 0.5% of the variance in students' attitude scores can be attributed to the instructional strategy used. Therefore the null hypothesis (H_0) was not rejected, the concluding no significant difference exists between flipped classroom and project-based methods in shaping students' attitudes toward drawing biological diagrams.

Table 3: Pretest and posttest mean effects of flipped classroom and project-based instructional strategies on students' engagement in drawing biological diagrams

Instructional Strategies	Pre-test			Post-test			Mean Difference
	N	\bar{X}	SD	\bar{X}	SD		
Flipped Classroom	42	29.97	5.80	40.74	4.61	10.77	
Project-Based	39	29.39	6.43	40.77	5.04	11.38	

Note: N = Number of Respondents, \bar{X} = Mean, SD = Standard deviation

In Table 3, students who learned biological diagram drawing through the flipped classroom approach had an average engagement score of 29.97 (SD = 5.80) before the lesson and 40.74 (SD = 4.61) afterward. Similarly, students taught using the project-based method scored 29.39 (SD = 6.43) on the pretest, increasing to 40.77 (SD = 5.04) on posttest. This reflects a gain of 10.77 and 11.38 points for the flipped classroom group and project-based group respectively indicating that both strategies improved student

engagement in biological drawing. This indicates that project-based instructional strategy had a slightly higher improvement in their engagement in drawing of biological diagrams than those taught using the flipped classroom strategy. In essence, though both flipped classroom and project-based instructional strategies are effective in promoting students' engagement in drawing of biological diagrams, the project-based instructional strategy appears to be more effective.

Hypothesis Two

Table 4: Analysis of covariance (ANCOVA) of the difference in the effects of flipped classroom and project-based instructional strategies on students' engagement in drawing biological diagrams

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared (η^2_p)	Dec.
Corrected Model	855.620 ^a	4	213.905	16.530	.000	.465	
Intercept	10000.700	1	10000.700	772.850	.000	.910	
PretestEBDDScores	738.548	1	738.548	57.075	.000	.429	
Groups	5.965	1	5.965	.461	.499	.006	NS
Error	983.442	76	12.940				
Total	136365.000	81					
Corrected Total	1839.062	80					

Note: df= Degree of Freedom, F= F-ratio, Sig.= Significant/probability value, Dec.= Decision, NS = Not Significant, S = Significant

Table 4 indicates that there was no statistically significant difference on how the flipped classroom and project-based strategies influenced students' engagement in drawing biological diagrams, ($F(1, 81) = 0.461$, $p = 0.499$, $\eta^2_p = 0.006$). The p-value of 0.499 exceeds the 0.05 significance threshold, suggesting any observed difference between the two groups is not meaningful. Furthermore, the partial eta squared value ($\eta^2_p = 0.006$) shows only 0.6% of students' engagement variation scores can be attributed to the instructional method used. Therefore, the second null hypothesis (HO2) was not rejected, concluding no significant difference between the flipped classroom and project-based strategies.

Discussion of Findings

Flipped classroom and project-based strategies enhance students' attitude towards drawing biological diagrams; project-based strategies appear more effective. Further analysis showed no significant difference between flipped classroom and project-based strategies regarding students' attitude towards drawing biological diagrams. Thus, flipped classroom and project-based strategies effectively enhance students' attitude in drawing of biological diagrams. The non-significant difference in strategies may result from their shared emphasis on active learning, collaboration, and knowledge application, positively influencing leaning attitudes. Studies by Jensen et al. (2023) and Herodotou et al. (2022) show that flipped and project-based strategies improve learning by encouraging student autonomy. However, the advantage of project-based learning comes from its focus on creativity and problem solving as noted by Simons et al. (2021). Wang and Guo (2022) found flipped classroom slightly more effective than project-based learning due to accessible

resources enabling self-paced learning. Contextual factors such as resource availability, teacher expertise, and student preferences may influence the effectiveness of these strategies."

The study found both strategies effective for engaging students in drawing of biological diagrams, but project-based strategy appears to be more effective. Further analysis showed no significant difference between flipped classroom and project-based strategies in students' engagement with biological diagrams. This finding can be attributed to the nature of project-based learning, which requires active participation and teamwork. Flipped classroom fosters engagement through prepared students, facilitating discussions and problem-solving. Project-based learning may have an edge due to its structured exploratory approach, aligning with skills needed for drawing biological diagrams.

The above study findings support previous scholars work. Rahman et al. (2023) found that project-based learning increased engagement. Lee and Hwang (2022) noted improved engagement with flipped classroom. Khalil and Saeed (2021), suggest that strategy success relies on implementation, teachers support and resource. Okoro and Akpan (2023) found no significant engagement differences between strategies, indicating shared active-learning may yield similar results, underscoring the need for varied instructional approaches.

Conclusion

Based on the findings of this study, it is concluded that both flipped classroom and project-based strategies boost secondary school attitudes and engagement in drawing biological diagrams. Project-



based strategy is slightly more effective but the difference is not statistically significant.

Recommendation

Teacher training should include active and student-centered methods, emphasizing for science education

Curriculum designers should integrate project-based learning into biology curricula to improve attitudes and engagement

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