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EFFECT OF EXPERIENTIAL AND TRANSFORMATIVE LEARNING STRATEGIES ON SENIOR SECONDARY STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN LAGOS STATE

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EFFECT OF EXPERIENTIAL AND TRANSFORMATIVE LEARNING STRATEGIES ON SENIOR SECONDARY STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN LAGOS STATE

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Abstract

This study was designed to assess the effect of experiential and transformative learning strategies on senior secondary students' academic achievement in biology in Lagos State. The study adopted the pretest-posttest, control group quasi-experimental design. The sample was 451 senior secondary II students selected using a purposive and multi-stage sampling technique from Education District IV in Lagos State. Instruments for data collection were the Biology Achievement Test (BAT) and Students' Socioeconomic Background Questionnaire (SSBQ). Three research questions and three research hypotheses guided the study. Data were analysed using mean, standard deviation, and Analysis of Variance (ANCOVA) at a 0.05 significance level. Post hoc analysis was done using the Bonferroni post hoc test. Parameter Estimates were used to analyse the magnitude of mean scores of the different groups. Results showed a significant main effect of experiential and transformative learning strategies on secondary students' academic achievement. Transformative learning strategy was the most effective, impacting secondary students' academic achievement in biology. Results also showed no significant influences of gender and socioeconomic background on students' academic achievement in biology. It was recommended that biology teachers adopt transformative learning strategy in teaching environmental concepts in biology to develop environmentally sustainable, literate citizens. It was also recommended that the Federal Government review and update the Nigerian Senior Secondary School Biology Curriculum to include contemporary and effective learning strategies such as transformative learning strategy.

Introduction

Environmental degradation is a major challenge bedeviling humanity. According to Climate Change and Environmental Degradation Risk and Adaptation Assessment, CEDRA (2009), environmental degradation is the consequence of past and present generations using up or damaging natural resources faster than nature can restore them, such that few, if any, of those resources remain for the next generation. Environmental degradation and impacts may include, for

example, the destruction of forests, causing soil degradation and threatened agricultural livelihoods; the building of dams or diversion of rivers upstream, causing water shortages and increased workloads to collect water, and the destruction of coastal protection such as mangroves, leading to exposure to storm damage. The impacts also include waterlogging of soils, relocation of communities, and air pollution from factories using chemicals, causing increased ill health.

The efforts aimed at containing environmental degradation have mostly been through international treaties and policies, and many such policies are slow to make any headway. The seriousness of the situation and the danger of environmental degradation can no longer be downplayed. The situation requires nothing less than education. The ability of education to inspire, engage, empower, and inform people of the environmental emergency, including its causes and impacts, is acknowledged in international climate agreements (Education International, 2019). However, this recognition must be translated into action plans. It is imperative to educate citizens capable of addressing contemporary societal challenges, particularly those threatening the environment. Students should be viewed as integral to the solution, and science education plays a critical role in empowering them for this responsibility (Jensen, 2002). Consequently, science education, specifically biology continues to pursue more effective teaching strategies to promote both academic proficiency and environmental sustainability.

Biology is a subject in the field of science and also one of the science subjects at the senior secondary level in Nigeria, carrying environmental content. It is the science of life that studies living matter, structure, function, and behaviours of organisms and is also concerned with the evolution, distribution, and taxonomy of life. The study of Biology intends to equip the learners with knowledge, skills, and attitudes vital in enabling them to protect and conserve the environment, control the population, combat diseases, and improve food production. In addition, Biology enables students to enter career sectors such as education, health, agriculture, and the environment. The importance of biology as a school subject for sustainable living cannot be overemphasized (Ahmad, Abubakar & Yau, 2018). The environmental concepts in the Nigerian biology curriculum that have been included to promote environmental literacy are basic ecological concepts, functioning ecosystems, energy transformation in nature, aquatic and terrestrial habitats, nutrient cycling in nature, ecological management, and conservation of natural resources (NERDC, 2011).

Research has shown that despite the importance of Biology, students' academic achievement in the subject at the secondary level has been inconsistent over the years (Ayuba, 2016; Awobodu, 2016; Raji, 2017 & Adebanjo, 2020). The performance of students in Biology has reportedly been inconsistent, as shown in Table 1 below.

Table 1: Candidates' Performance in May/June West African Senior Certificate Examination in Nigeria from 2014 to 2021.

Year	Total Sat	Credit Passes	%
2014	1,365,384	766,791	56.17
2015	1,260,000	427,644	33.94
2016	1,340,489	383,112	28.58
2017	1,300,630	645,633	49.64
2018	1,505,409	579, 432	38.49
2019	1, 646,225	587,044	35.66
2020	1,698, 187	564,138	33.22
2021	1,692,535	529,425	31.28

Source: West African Examination Council.

From the table, the performance of candidates in 2014 was slightly above the average of 50%. 2015 showed a decrease in performance. In 2017, the performance increased slightly, and 2018 to 2021, witnessed a further drop in performance. The table shows that the performance is inconsistent. Kurah (2015) and Adebanjo (2020) attributed the low and inconsistent performance to inappropriate teaching methods and faulty learning strategies, among others. Furthermore, Raji (2017) and Adebanjo (2020) reported that most biology teachers in secondary schools were using the traditional chalk-and-talk method to teach and this has consistently led to poor academic performance of the students. Also, it is seen that traditional approaches to solving environmental problems are not successful as humans continue to engage in environmentally unfriendly behaviours at the individual, corporate, governmental, and societal levels (Uyanık, 2016).

In addition to teaching problems, the poor performance of Nigerian candidates in the School Certificate Biology Examinations conducted by the West African Examination Council has also been attributed to some topics in biology that students find difficult to answer correctly (Raji, 2017 & Adebanjo, 2020). Etobro and Fabinu (2017) discovered that students usually have difficulties in five major topics. The topics are nutrient cycling in nature, ecological management, conservation of natural resources, pests and diseases of crops as well as reproductive systems in plants. It is important to point out that a proper understanding of these topics by biology students could assist in improving their performance in biology and make them environmentally sustainable citizens. According to Ajayi (2017), the responsibility of the classroom teacher is to help students attain maximum achievement in their learning tasks by the use of effective pedagogic approaches such as experiential and transformative learning strategies.

Experiential learning strategy is rooted in the early work of John Dewey and later developed by Jean Piaget, Lev Vygotsky, and David Kolb. It aligns with constructivism, which posits that learners construct meaning from their experiences, Awolere (2015). Experiential learning strategy is the process where the focus of the learning is placed directly within the learner and is characterized by students' active participation in the learning process so that learning becomes interactive, cooperative, and collaborative. The most widely cited experiential learning model is Kolb's learning cycle, which is in four continuous stages. The stages are Concrete experience, reflective observation, abstract conceptualization, and active experimentation. The learner has a concrete experience and makes observations and reflections based on the experience. The

observations and reflections are assimilated into a new conceptual understanding and interpretation of the meaning of the experience, and this conceptual understanding is translated into actionable knowledge that is applied and then used to guide new experiences, Awolere (2015).

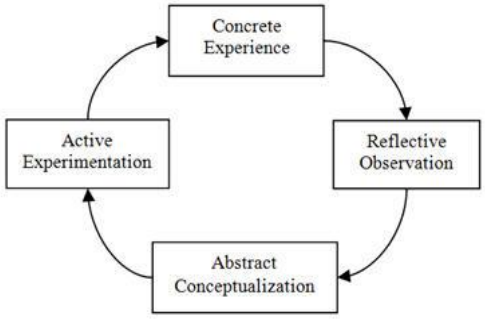

Figure 1: Kolb's Cycle of Experiential Learning. Adopted from serc.calteton.edu

Experiential learning allows for increased learning because knowledge is gained through active participation, and experience acts as a catalyst for dialectic inquiry, according to Olatunde (2017). Okuakaji and Sukolatambaya (2020), in a related study, investigated the effect of experiential learning strategy on biology students' academic achievement in Dutsin– ma Local Government Area of Katsina State. The study employed a quasi-experimental research design. The population for the study comprised 718 Senior Secondary II biology students. A simple random sampling technique was used to select two schools in Dutsin–Ma LGA. The instrument for data collection was the Biology Achievement Test (BAT). The data were analyzed using mean, standard deviation, and t-test. The result revealed that the experiential learning strategy is superior to the traditional lecture method in facilitating student's achievement in biology.

Nwuba and Osuafor (2021) in their study also investigated the effect of experiential learning approach on secondary school students' academic achievement in biology in Awka Education Zone, Anambra State. The study adopted a quasi-experimental design, specifically the pretest-posttest non-equivalent control group of 2x2 factorial research design. A multistage sampling procedure was employed to compose the sample size of fifty–three (15 males and 38 females). A Biology Achievement Test (BAT) developed by the researcher using compiled secondary school certificate examination (SSCE) biology past questions was used for data collection. Mean, standard deviation, and Analysis of Covariance (ANCOVA) was used to analyse the data obtained from the study. Findings of the study revealed that the use of an experiential learning approach is more effective in enhancing students' academic achievement in biology than the traditional learning approach.

Furthermore, Ayeni (2022) investigated the effects of experiential learning and problem–solving strategies on the academic performance of Biology students at the senior level in some senior secondary schools located in south-west Nigeria. The research design for the study was quasi-experimental research of the pre-test post-test control group. The sample consisted of 240 SS2 Biology students selected through a multistage sampling procedure. Biology Performance Test was used to generate data for the study. Data were analysed using mean, standard deviation, t-test, Analysis of Covariance (ANCOVA), and multiple classifications Analysis (MCA). The finding showed that there was low performance in experiential learning, problem-solving, and control groups before the treatment. After the experimental group was exposed to experiential learning

and problem-solving strategies, their performance was high compared to that of their counterparts in the control group.

Transformative learning is the process by which learners change their taken-for-granted frames of reference (meaning schemes, habits of mind, mindsets) to make them more inclusive, discriminating, open, emotionally capable of changing and reflective so that they may generate views that will prove more accurate to guide their actions (Mezirow, 2003). Frames of reference are also referred to as ways of thinking and acting, attitudes, values, and beliefs that are the result of experiences, and they define an individual's life world. They could be seen as the cognitive building blocks that support deep changes in values, attitudes and associated behaviour that are central to evolving how individuals respond to living with environmental changes, Mezirow (1997) as cited in Sharpe (2016). In transformative learning, meaning is created through learning, and learning is achieved when students revise their habits of mind and points of view through reflection and dialogue (Mezirow, 2003). It goes beyond simple knowledge acquisition and supports critical ways learners consciously make meaning of their lives (Simsek, 2012). There are ten possible phases of the transformative learning strategy, according to Mezirow; these are a disorienting dilemma, a self–examination with feelings of culpability, a critical assessment of assumptions, recognition that one's discontent and the process of transformation is shared and that others have negotiated a similar change, explorations of options for new roles, planning a course of action, acquiring knowledge and skills for implementing the plan, provisionally trying out new roles, building self-confidence in new roles and reintegration into one's live based on conditions dictated by one's perspectives. According to Mezirow, these ten phases fall under four components of the transformative learning process, which are experience, critical reflection, reflective discourse, and action.

Transformative learning allows learners to question their assumptions, both current and prior, which then have the potential to change as a result of experience, Slavich & Zimbardo (2012). Teachers in a transformative learning classroom are facilitators who engage students in interdependent discovery involving problem–solving, discourse, and critical reflection. In a study carried out by Maichibi, Ozoji, and Chollom (2023) to investigate the effects of transformation learning strategy on academic achievement of junior secondary three students in basic science and technology in Jaba-Kaduna state, they found that transformation learning strategy improved achievement in the experimental group more than the control group.

Academic achievement is one of the most important outcomes of formal educational experiences. It is the extent to which students attain a short or long–term educational goal. Student's academic performance is affected by several factors, which include the lack of proper teaching materials, poor teaching methods, age, gender, poor health, parents' socioeconomic background, and educational background, Akinsola (2019). Poor academic achievement not only results in the learner having low self–esteem, it also causes sufficient stress to the parents and teachers. It is therefore important to develop learning strategies that could assist the learner to perform up to full potential (Karande & Kulkarni, 2005). According to Adesoji and Idika (2015), there is a need to derive new teaching and learning strategies to promote active learning in students. It is therefore necessary to introduce learning strategies such as experiential and transformative learning strategies that would support active learning in biology classrooms (Kovacevic, 2005), as cited in Peko and Varga (2014). This research adopted gender and socioeconomic background as moderator variables for the study.

Gender is one of the variables that have been found to influence students' academic achievement. Gender differences have become critical issues of concern worldwide, especially among educators and researchers. Hansman, Tyson, and Zahidi (2009) reported that no country in the world has yet reached equality between women and men in different critical areas such as education. Gender is categorized as male or female, and previous research has examined gender differences in various variables. Udeani and Okafor (2012) mentioned that over the past few decades, the wide gap in science performances between male and female students has been considerably reduced, but the gender gap persists. They further stated that a lot of reasons have been given for this gap, and the instructional strategy used is high on the list. Research has shown inconsistent findings on gender differences and academic achievement (Oladipo, 2016). Falemu and Akinwumi (2021) investigated the effects of practical biology work on the academic performance of secondary school students. The results revealed that there was no clear difference between females and males in academic achievement in biology. Ekineh and Adebanjo (2020) investigated how students' academic achievement in Biology can be improved using information and communication technology-aided instruction**.** Findings indicated that there was a significant effect of ICT-aided instruction on students' achievement in Biology. However, no significant main effect of gender was found on students' achievement in Biology. Also, Eseine–Aloja (2021), in a study, investigated the effects of gender on the academic performance of biology students who attend extra–mural classes in public senior secondary schools. The results showed that there was a significant statistical difference in the performance of male biology students with male students performing better. Studies on the effect of gender on students' acquisition of scientific concepts have not documented a regular pattern or sequence of achievement (Bilesanmi – Awoderu, 2002) hence, the need to also determine its influence in this study.

Parents' socioeconomic background is also a major contributing factor, which affects the academic achievement of biology students (Akachukwu, Adimonyemma & Igboabuchi, 2018). According to Ghaemi and Yazdanpanah (2014), the American Psychological Association (2022) conceptualized socioeconomic background as the social standing or class of an individual or group, often measured as a combination of education, income, and occupation. Alken and Barbarin (2008) asserted that families from low socioeconomic backgrounds communities are less likely to have the financial resources or time available to provide children with academic support thus negatively affecting students' academic progress. On the other hand, families that fall within high socioeconomic backgrounds often have more access to a wide range of resources to promote and support young children's development. They also asserted that the low educational and occupational background of many parents has been viewed as an influential determinant of students' memory and academic achievement.

In a study, Akpan (2020) investigated socioeconomic background and academic performance of biology students in public secondary schools in Obot Akara Local Government Area of Akwa Ibom State. The findings of the study revealed that parental income, family size, parental occupation, and parental education background had a significant influence on academic performance. Oladele, Abubakar, and Adawa (2021) in their study examined the impact of parents' income and educational background on students' academic achievement in educational technology in Niger State. The study revealed that students study daily and differently regardless of their parent's income, and the parent's income varies. Thereby, students tend to attain academic achievement despite their parent's income. Etobro (2021) investigated parental socioeconomic status, parenting styles, and academic performance of secondary school students in Ojo Local Government Area, Lagos State. It was found that parental socioeconomic status and parenting

styles significantly contributed to the students' academic performance. Also, Odikpo and Ejide (2021) examined the influence of parental occupation and educational level on the academic achievement of Senior Secondary Two (SS2) students in English language and Mathematics in Ogidi and Otuocha Education Zones of Anambra State, Nigeria. The result revealed that parental occupation and education influenced the academic achievement of SS2 students in English language and mathematics.

Anetor (2021) also examined the influence of parents' socioeconomic background on the academic performance of senior secondary students in Rivers State. The findings of the study revealed that parents' socioeconomic background influences the students' academic performance. Egbo and Agbo–Peters (2020) examined the influence of the socioeconomic background of parents on the academic performance of secondary school students in the Enugu Education Zone of Enugu State. The result obtained from the analysis showed that parental qualification, background, income, and occupation influence the academic performance of secondary school students to a great extent.

Statement of the Problem

Environmental sustainability is achieved when students possess correct knowledge that enables them to learn behaviour changes which in turn help them to take action to protect our shared environment – air, water, land, and ecosystems – in ways that are economically viable, beneficial to human health and well – being, and socially just in the long term (USEPA, 2017).

Teaching and learning of environmental concepts in the Nigerian Senior Secondary School Biology Curriculum (NSSSBC) still follows the traditional ways. Teaching and learning methods are often formal and emphasis is on rote memorization to pass examinations instead of understanding environmental issues and their concepts. This has led to poor students' academic achievement in biology and their inability to connect classroom learning with real-life situations. Innovative and active pedagogical strategies that should ensure higher levels of teaching and learning, which should develop learners' skills necessary to bring about a significant shift in the present relationship of humans with nature, to change the current unsustainable practices, and make responsible decisions to act for resolving environmental problems are rare (Hays & Reinders, 2020).

Purpose of the Study

The main purpose of the study was to improve senior secondary students' academic achievement using experiential and transformative learning strategies in biology.

Specifically, the study sought to;

1. Determine the main effect of treatments (experiential and transformative learning strategies) and traditional learning strategy on secondary students' academic achievement in biology.
2. Investigate the main effect of gender on secondary students' academic achievement in biology.
3. Verify the main effect of socioeconomic background on secondary students' academic achievement in biology.

Research Questions

The following research questions were raised for the study;

1. What is the main effect of treatments (experiential and transformative learning strategies) and traditional learning strategy on secondary students' academic achievement in biology?
2. What is the main effect of gender on secondary students' academic achievement in biology?
3. What is the main effect of socioeconomic background on secondary students' academic achievement in biology?

Research Hypotheses

The following null hypotheses were tested in the study;

H_{01}: There is no main effect of treatments (experiential and transformative learning strategies) and traditional learning strategy on secondary students' academic achievement in biology.
H_{02}: There is no main effect of gender on secondary students' academic achievement in biology.
H_{03}: There is no main effect of socioeconomic background on secondary students' academic achievement in biology.

Research Design

This study adopted a pretest-posttest control group quasi-experimental design.

The population for the study was twelve thousand one hundred and one (12,101) senior secondary II students in Education District IV in Lagos State. The senior secondary II classes were selected because, at this class level, the students are not engaged with preparations for any external examinations and are expected to have some prior knowledge of environmental concepts as recommended by the Nigerian Senior Secondary School Biology Curriculum (NSSSBC), NERDC (2011). The sample for this study was selected using purposive and multi-stage sampling techniques. In the first stage, the researcher selected one of the six education districts in Lagos State using a simple random sampling technique. In the second stage, simple random sampling was repeated to pick 2 Education Zones out of the 3 Education Zones that comprise the Education District. Mainland and Surulere Education Zones were selected from Education District IV. In the third stage, a simple random sampling technique was used to select three of the eight schools that satisfied the criteria for selecting schools for the study in Mainland Education Zone. Three schools were selected out of the 23 that met the set criteria for the study in Surulere Education Zone. In the final stage, intact classes in the schools selected in each Education Zones were assigned to experimental and control groups . In each zone, one school was randomly selected as the control group, one for the Experiential Learning Strategy, and one for the Transformative Learning Strategy. This comprised six schools selected for the study; 2 intact classes were selected as control groups, 2 as Experiential Learning Strategy, and 2 as Transformative Learning Strategy. The set criteria for the sampling of the schools were that they are co-educational and have graduate biology teachers who must have taught the subject for at least five years. Other criteria were that the schools had fairly equipped and accessible biology laboratories. Figure 2 shows a Consort-style flow diagram showing participant allocation and attrition.

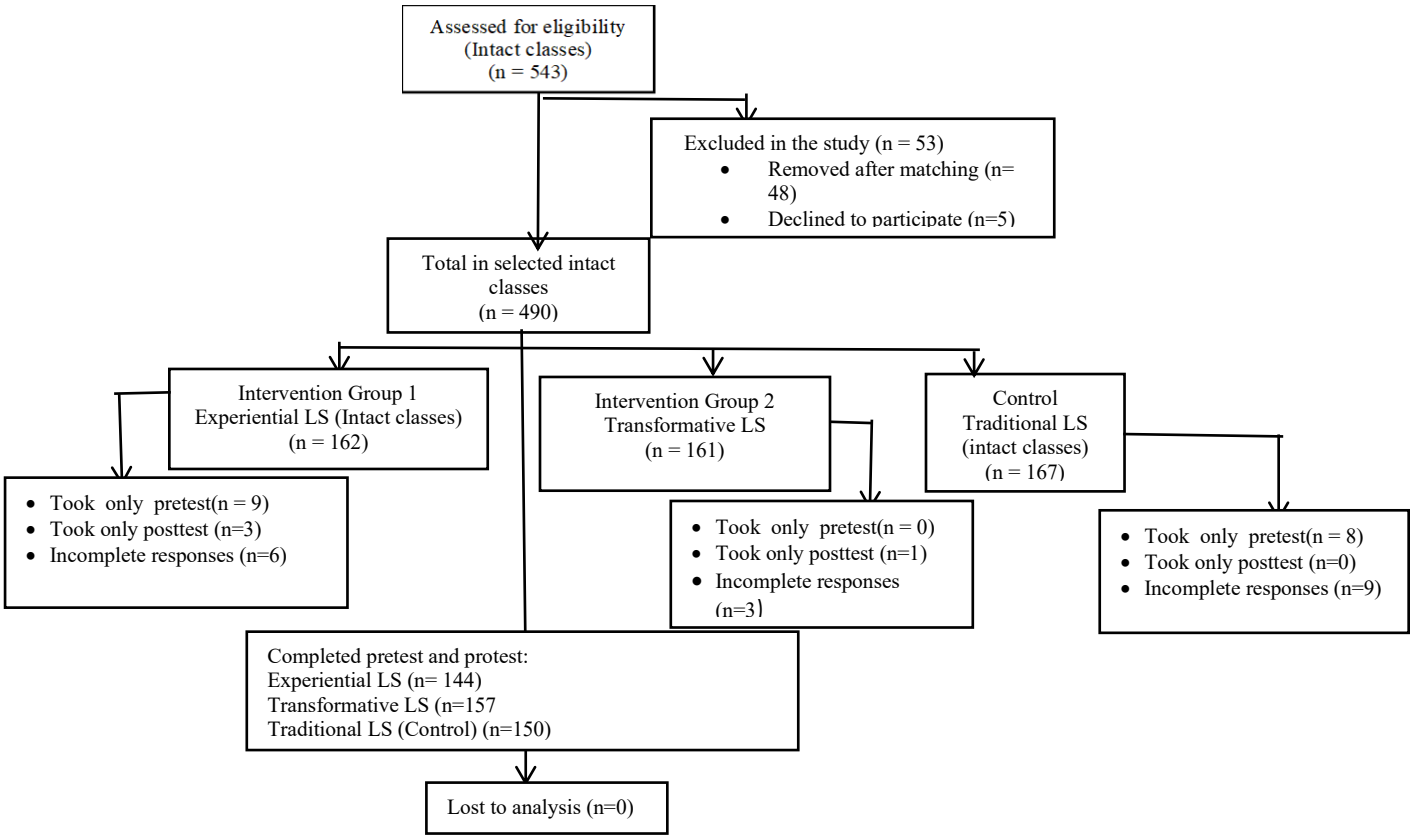

Figure 2: A CONSORT-style flow diagram showing participant allocation and attrition.

Source: The Researcher

A total of 543 secondary students were initially sampled, of which 451 participants completed the pre- and post-tests and fully participated in the intervention administered to the students in their intact classes. Experiential (n = 144), Transformative (n = 157), and Traditional (n = 150). To determine the adequacy of the sample size, power analysis was performed using G*Power 3.1 for analysis of covariance (ANCOVA) with three groups and three covariates (pretest achievement, gender, and socioeconomic background) at a significance level of $\alpha = 0.05$ and power $(1 - \beta) = .80$, the analysis followed Cohen's (1988) guidelines for effect size: $f = 0.10$ (small), $f = 0.25$ (medium), and $f = 0.40$ (large). Results indicated that, to detect a medium effect, the sample size required a minimum of 159 participants, whereas 969 would be required for a small effect, and 66 for a large effect. Given the final sample size of 451 participants, the study had >99% power to detect medium and large effects, and approximately 32%–47% power for small effects. This level of statistical power is consistent with the expectations for educational intervention research, where medium effects are commonly observed (Cohen, 1988). To minimise bias associated with the pretest, posttest control group quasi-experimental design, intact classes were used, and students were matched across groups by gender and socioeconomic background. These variables, along with pretest scores, were included as covariates in the ANCOVA to control for pre-existing differences and enhance the internal validity of the analysis.

The instruments used to collect relevant data in this study are the Biology Achievement Test (BAT) and the Socioeconomic Background Questionnaire (SSBQ). The BAT comprised 32 multiple-choice items derived from four concepts: nutrient cycling in nature, ecological management, pollution, and conservation of natural resources. It measured students' academic achievement in biology. The reliability of the BAT was determined using the Kuder-Richardson formula 20. It had a reliability index of 0.70. The Socioeconomic Background Questionnaire (SSBQ) was a composite index-based instrument adapted from the revised scoring scheme for classifying socioeconomic status in Nigeria, developed by Ibadin and Akpede (2021). It included factors such as parental education, household income, and parental occupation. Household income was classified as low (≤ ₦428,145 annually), medium (₦428,146–₦1,000,000), or high (≥ ₦1,000,001). Parental education levels were categorised as low (primary or below), medium (secondary/vocational), or high (tertiary), while occupations were grouped into low (unskilled/informal), medium (skilled/technical), and high (professional/managerial). Students were categorised based on their responses to the questionnaire. The reliability of the SSBQ was determined using the internal consistency of Cronbach's Alpha, which yielded a reliability index of 0.70.

Pretest of Biology Achievement Test (BAT) was administered to the students in their intact classes, in the schools randomly selected for the study. This was done to determine the entry behaviours of the students before they were exposed to the treatments. The class teachers of the intact classes selected for the study assisted the researcher in the administration of the research instrument.

The biology teachers were trained and assisted in implementing the learning strategies in the appropriate schools selected as treatment schools. The teachers used instructional guides relevant to the treatment groups in the schools selected for the study. The researcher visited the schools once a week to ensure that the teachers were implementing the learning strategies appropriately. The treatment lasted for 7 weeks, consisting of a double period of 80 minutes per week.

The post-test of the research instrument was administered to the same set of students who took the pre-test in both experimental and control groups after treatment. The same instrument used for the pre-test were used for the post-test. The questions were scrambled to change the positions of the questions in the pre-test. This was to determine the effectiveness of the instructional strategies in improving the student's academic achievement in Biology. The administration of the post-tests lasted for one week.

Data obtained from valid responses to the research instruments were analysed using descriptive statistics of mean and standard deviation and inferential statistics of Analysis of Covariance (ANCOVA) at 0.05 level of significance. Prior to ANCOVA analysis, assumptions were tested. The interaction between pretest scores and group was non-significant ($p>0.05$), confirming homogeneity of regression slopes as shown in Figure 3. Linearity between pretest and posttest scores was supported by scatterplot as shown in Figure 4. Pretest scores were collected before intervention, ensuring covariate independence. Normality and homogeneity of variance were confirmed through residual plots and Levene's test ($p>0.05$). These results indicated that ANCOVA assumptions were met, validating the analysis. Post hoc analysis was done using the Bonferroni post hoc test. The post hoc test was done to verify the source of the significant difference in the case where treatments had a significant main effect on dependent variables. The choice of this post hoc test was its ability to detect true differences between groups. Parameter Estimates was used to analyze the magnitude of mean scores of the different groups.

1. Assumption of Homogeneity of Regression slopes

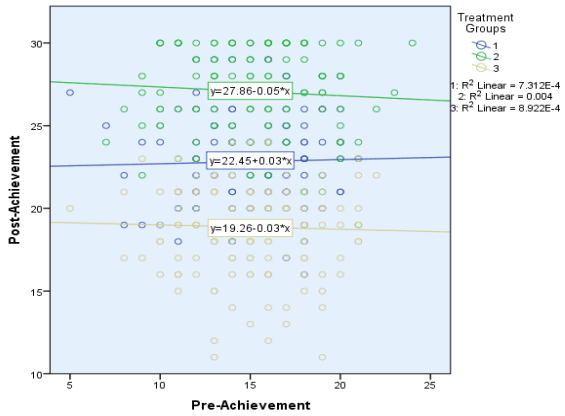

Figure 3 Homogeneity of regression slopes showing no significant interaction between covariates and treatment.

Group 1= Experiential Learning Strategy, 2= Transformative L and 3= Traditional LS

The scatter plot revealed near-parallel trend lines across the three learning strategy groups, indicating a consistent relationship between pretest and posttest achievement scores. This parallelism suggests that the effect of pre-achievement on post-achievement was uniform across groups, thereby supporting the assumption of homogeneity of regression slopes required for ANCOVA.

2 Linearity Assumption

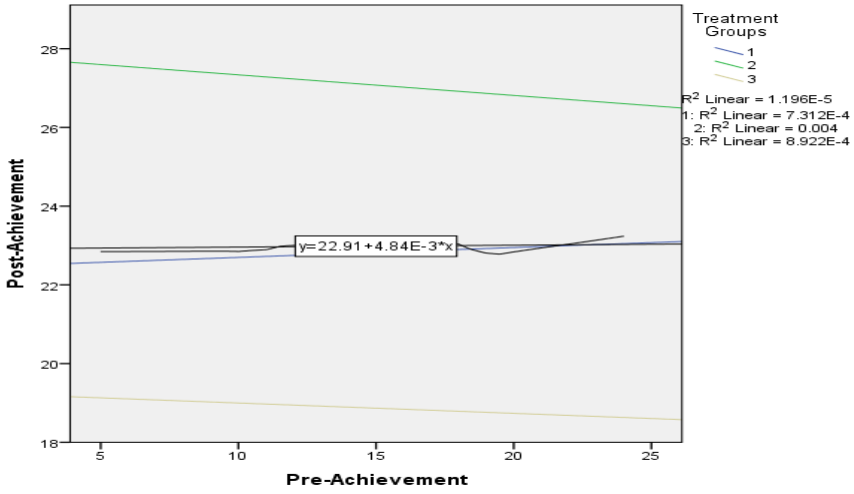

Figure 4: Scatter plots showing linearity assumption of ANCOVA

Scatterplots showed approximately linear relationships between pre- and post-achievement across groups, with minimal slopes and no curvature. Despite low R^2 values, the assumption was deemed adequately met.

3. Normality Assumption:

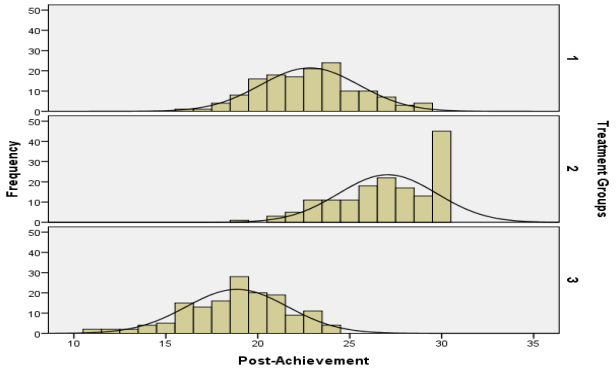

Figure 5: Histograms showing that the residuals are approximately normally distributed.

Tests of Normality

	Treatment Groups	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Post-Achievement	1	.095	144	.003	.981	144	.044
	2	.151	157	.000	.903	157	.066
	3	.126	150	.000	.970	150	.002

a. Lilliefors Significance Correction

Table 2: Shapiro Wilk's test of Normality

The Shapiro-Wilk test indicated significant deviations from normality in post-achievement scores across groups: Experiential ($W = .98, p = .044$), Transformative ($W = .90, p < .001$), and Traditional ($W = .97, p = .002$). However, given the large sample sizes and ANCOVA's robustness to moderate non-normality (Blanca et al., 2018), the assumption was considered sufficiently met.

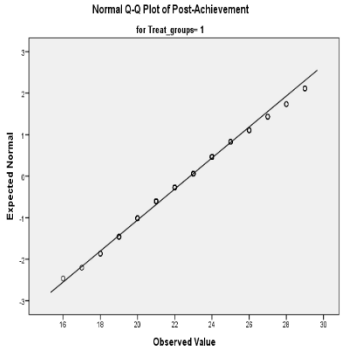

Figure 6a

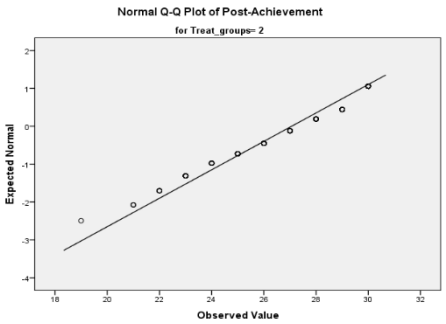

Fig 6b

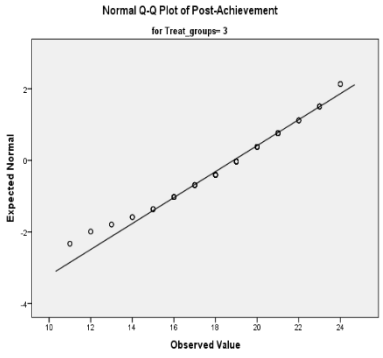

Fig 6c

The normality of residuals was assessed using the Normal Q-Q Plot. The Normal Q-Q Plot showed that standardised residuals closely followed the diagonal line, indicating approximate normality.

4. Homogeneity of Variance Assumption

F	df1	df2	Sig.
.072	2	448	.930

Table 3: Leven'e test results showing that the variances of the groups are statistically similar.

Results

Research Questions 1: What is the main effect of treatments (experiential and transformative learning strategies) and traditional learning strategy on secondary students' academic achievement in biology?

Treatment Groups	Mean	Std. Deviation	N
Experiential LS	22.83	2.679	144
Transformative LS	27.06	2.664	157
Traditional LS	18.87	2.756	150

Table 4: Descriptive Statistics of Post-Achievement Scores based on Treatments.

Table 4 indicated that Transformative Learning Strategy had the highest mean post-achievement score ($\overline{x}$= 27.06, SD = 2.66), followed by Experiential Learning Strategy $\overline{x}$= 22.83, SD = 2.68), and Traditional Learning Strategy $\overline{x}$= 18.87, SD = 2.76. The treatments, therefore, had positive effects on students' academic achievement in biology. The results showed that the students exposed to transformative learning strategy had the highest post-mean scores of academic achievement compared with the students in Experiential learning strategy and Traditional learning strategy.

Research Question 2: What is the main effect of gender on secondary students' academic achievement in biology?

Table 5: Descriptive Statistics of Post-Achievement Scores based on Gender

Gender	N	Mean	Std. Deviation
Male	239	22.96	4.381
Female	212	23.01	4.275

Table 5 displayed that male students ($\overline{x}$= 22.96, SD = 4.38) and female students ($\overline{x}$= 23.01, SD = 4.28 achieved comparable posttest scores in academic achievement. The minimal difference in means suggests that gender may not substantially impact post-achievement outcomes.

Research Question 3: What is the main effect of socioeconomic background on secondary students' academic achievement in biology?

Table 6: Descriptive Statistics of Post-Achievement Scores based on levels of socioeconomic background.

Socioeconomic Background	Mean	Std. Deviation	N
Low	22.34	4.337	32
Medium	23.00	4.349	332
High	23.16	4.267	87

Table 6 illustrates that students with high socioeconomic background had higher achievement mean scores of $\overline{x}$ = 23.16, SD = 4.267 than the students in the medium socioeconomic background ($\overline{x}$ =23.00 SD = 4.349) and low socioeconomic background ($\overline{x}$ =22.34, SD = 4.337).

Research Hypothesis H_{01}: There is no main effect of treatments (experiential and transformative learning strategies) and traditional learning strategy on secondary students' academic achievement in biology.

Table 5a: Summary of the Analysis of Covariance (ANCOVA) of Post-test scores of Achievement by Treatments, Gender and Socioeconomic background

Tests of Between-Subjects Effects

Dependent Variable: Post-Achievement

Source	SS	df	MSe	F	Sig.
Corrected Model	5226.898[a]	18	290.383	39.226	.000
Intercept	8648.309	1	8648.309	1168.254	.000
Pre-Achievement	1.138	1	1.138	.154	.695
Treatments	2134.540	2	1067.270	144.172	.000
Gender	2.289	1	2.289	.309	.578
Socioeconomic Background	16.053	2	8.027	1.084	.339
Treatments * Gender	21.718	2	10.859	1.467	.232
Treatments * Socioeconomic Background	1.702	4	.425	.057	.994
Gender* Socioeconomic Background	11.211	2	5.605	.757	.470
Treatments * Gender * Socioeconomic Background	26.506	4	6.627	.895	.467
Error	3197.993	432	7.403		
Total	246682.000	451			
Corrected Total	8424.891	450			

a. R Squared = .620 (Adjusted R Squared = .605)

The results in Table 5a indicated that F (2, 450) = 144.172, η^2 = 0.400, and p = 0.00 (p < 0.05). This suggests a significant effect of treatments on students' academic achievement, with an effect size of 40.0%. The null hypothesis, which stated that there is no main effect of treatments (experiential and transformative learning strategies) and traditional learning strategy on secondary students' academic achievement in biology, was rejected.

Table 5b: Parameter Estimates of Treatments for Achievement

Dependent Variable: Post-Achievement

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Squared
Intercept	18.266	.941	19.419	.000	16.417	20.114	.459
Pre-Achievement	-.021	.041	-.501	.616	-.102	.060	.001
Gender	.169	.256	.661	.509	-.333	.672	.001
Socioeconomic Background	.311	.255	1.219	.223	-.191	.813	.003
Experiential LS	3.965	.316	12.554	.000	3.345	4.586	.262
Transformative LS	8.204	.309	26.579	.000	7.598	8.811	.614
Traditional LS	0[a]	.	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Table 5b showed that Transformative Learning Strategy has the most significant main effect at $t = 26.58$, $p < 0.05$.This was followed by Experiential Learning Strategy at $t = 12.55$, $p < 0.05$. The result also showed that the transformative learning strategy had an effect size of 61.4%, and Experiential learning strategy had an effect size of 26.2%.

Table 5c: Post Hoc Tests: Pairwise Comparison of Means of Achievement.

Pairwise Comparisons

Dependent Variable: Post-Achievement

(I) Treatment Groups	(J) Treatment Groups	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	95% Confidence Interval for Difference[b] Upper Bound
Experiential LS	Transformative LS	-4.239*	.312	.000	-4.989	-3.489
	Traditional LS	3.965*	.316	.000	3.206	4.724
Transformative LS	Experiential LS	4.239*	.312	.000	3.489	4.989
	Traditional LS	8.204*	.309	.000	7.462	8.946
Traditional LS	Experiential LS	-3.965*	.316	.000	-4.724	-3.206
	Transformative	-8.204*	.309	.000	-8.946	-7.462

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

The pairwise comparisons' results in Table 5c revealed that transformative learning strategy is the most effective, which significantly improved students' academic achievement. It had a higher significant mean difference of 8.104 compared to the traditional learning strategy. Experiential learning strategy also achieved a mean difference of 3.965. These findings suggest a clear hierarchical pattern of effectiveness among the learning strategies: Transformative LS > Experiential LS > Traditional LS.

Research Hypothesis H_{02}: Gender will have no effect on secondary students' academic achievement in biology.

The results in Table 5a indicated that gender did not have a statistically significant effect on post-achievement scores: F (1, 450) = 0.309, η^2 =0.003, p = 0.001, (p > 0.05). This suggests that male and female students performed similarly. Therefore, the null hypothesis that gender will have no effect on secondary students' academic achievement in biology was accepted.

Research Hypothesis H_{03}: Socioeconomic background will have no effect on secondary students' academic achievement in biology.

Table 5a. presented that $F_{(2,450)} = 1.084$, $\eta^2 = 0.005$, $p = 0.339$ $(p > .05)$. This implied that socioeconomic background had no significant effect on secondary students' academic achievement in biology. Therefore, the null hypothesis, which states that socioeconomic background will have no effect on secondary students' academic achievement in biology, was accepted.

Discussion of findings

The study showed that there was a significant main effect of treatments on students' academic achievement in biology. Transformative learning strategy was more effective than experiential learning, which in turn was more effective than the traditional learning strategy. The parameter of estimates for the effect of treatments on students' academic achievement indicated that Transformative learning had the highest mean value followed by Experiential learning strategy and Traditional learning strategy.

The effectiveness of transformative learning strategy in bringing about significant improvements in students' academic achievement more than experiential and traditional learning strategies may be because it enhances critical thinking skills in the students, fosters greater engagement by making learning relevant and meaningful through active participation and cooperation in the classroom. When students engage deeply with learning materials through critical reflection and discussion, they are more likely to retain information and apply it effectively. By challenging existing beliefs and engaging with diverse perspectives, students develop stronger analytical skills. These skills are crucial for academic success. Transformative learning connects academic content with real–world issues, thereby making learning more meaningful for the students and improving retention of knowledge when they connect new information with their existing knowledge through reflective practices. This finding is in support of Maichibi, Ozoji and Chollom (2023) who found that the use of transformation learning strategy enhances students' achievement. The finding also supports Cottafava, Cavaglia, and Corazza (2019), who found that the empowerment of students happens through a transformative learning experience.

Experiential learning strategy was more effective in bringing about improvements in students' academic achievement than the traditional learning strategy. This finding is in agreement with Okuakaji & Sukolatambaya (2020), Nwuba & Osuafor (2021), and Ayeni (2022) that experiential learning strategy is superior to the traditional learning strategy in facilitating students' achievement in biology. The study's result showed no significant main effect of gender on students' academic achievement in biology. The finding is similar to the finding of Ekineh & Adolphus (2019) that gender does not affect students' performance in biology. The study also found no significant main effect of socioeconomic background on students' achievement in biology. The study findings are not in agreement with those of Akpan (2020), Etobro (2021), Odikpo & Ejide (2021), Anetor (2021), and Egbo and Agbo–Peters (2020), who found that parental socioeconomic backgrounds

influence students' academic achievement. The study finding is not in agreement with that of Oladele, Abubakar & Adawa (2021), who found that students attain academic achievement despite their parents' income.

Conclusions

The research findings observed that experiential and transformative learning strategies are effective in improving senior secondary students' academic achievement in biology. Transformative learning strategy was superior to experiential and traditional learning strategies. The study found that gender and socioeconomic background had no effect on students' academic achievement in biology.

Recommendations

The following recommendations are made based on the results obtained from the study;

1. Teachers should use a transformative learning strategy to foster classroom environments where students can connect theoretical knowledge with practical applications, enhancing their academic achievement.
2. It is recommended that the Federal Government reviews and updates the Nigerian Senior Secondary Students Biology Curriculum to include contemporary and effective learning strategies, such as Transformative learning strategy.
3. The Government should ensure that teachers are constantly offered in-service training in the use of contemporary and effective learning strategies such as Transformative learning strategy and ensure that they are appropriately implemented through close monitoring.
4. The government should provide enough learning materials that include relevant activities for both the teachers and the students to use when using transformative learning strategy in the classroom.

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