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IMPROVING PHYSICS EDUCATION IN DELTA STATE: AN INVESTIGATION OF THE EFFECTIVENESSOF EXPERIENTIAL LEARNING, BRAINSTORMING, AND LECTURE INSTRUCTIONAL STRATEGIES ON STUDENTS' ACHIEVEMENT

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ABSTRACT

This study investigated the effects of experiential learning, brainstorming, and lecture methods on students' achievement in physics in Delta State. Four research questions and hypotheses guided this study. The study employed the pretest, posttest, planned variation quasi-experimental design. The population of the study was 39,904 senior secondary two (SSII) Physics students in Delta State. A sample of 292 SSII physics students in six (6) intact classes was used for this study. The Physics Achievement Test (PAT), validated by three experts with a reliability coefficient of 0.79, was used for data collection. The mean, standard deviation, t-test, and Analysis of Covariance (ANCOVA) were used to examine the collected data. The results showed that there is a significant difference in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and lecture methods, in favour of the experiential learning instructional strategy group. The results further showed that there were no significant differences in the mean achievement scores of male and female students taught physics using experiential learning and brainstorming instructional strategies, and there was no significant effect of the interaction of methods and gender on physics students' achievement. The study, therefore, concluded that experiential learning and brainstorming instructional strategies enhance students' achievement in physics more than the lecture method. It was suggested that physics teachers should adopt experiential learning and brainstorming instructional strategies in teaching physics.

Keywords: Physics Education, Experiential Learning, Brainstorming, Lecture, Strategies, Student Achievement, Retention

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Introduction

Physics is one of the science subjects whose teaching and learning cannot be relegated to all over the world because of its enormous importance in the life of mankind. In the fields of science, technology, engineering, and mathematics (STEM), physics education is essential for developing critical thinking, problem-solving, and analytical skills. It is the scientific study of the natural world around us, focusing on the fundamental laws and principles that govern the behaviour of energy, matter, and the universe. As humans, we live in the natural world. Consequently, we all need to understand Physics to function effectively in our environment. This is buttressed by the first objectives of the Physics curriculum as stipulated by the National Policy on Education (2013), namely, to provide basic literacy in Physics for functional living in society and to stimulate and enhance creativity.

Ovuworie, Ajaja, Kpangban (2024) opined that the concepts of Physics explain most human physical activities or phenomena. For example, the concept of gravity in Physics explains why if we jump, we come down; the concept of friction explains why we can walk on a rough surface and the tendency to slip on a smooth surface; the concept of thermal expansivity explains the crackling sound we hear on our rooftops on a sunny day. Furthermore, the bottom of a clear river or pond, which appears shallower than it is, and the rod or spoon, which appears bent or broken when it is partially immersed in water or any liquid, are phenomena that are explained by the concept of refraction in physics. All of these are basic principles in physics, which justify the first objectives of physics. These also show how and why physics is indispensable, and its teaching in secondary schools cannot be relegated or neglected by any developing or developed nation that desires progress socio-economically and technologically.

However, despite the significance of physics, students still face challenges in grasping complex physics concepts, which often leads to low achievement and high attrition rates in physics. The Nigerian physics curriculum encounters issues, including poor student performance in physics examinations, low enrollment rates in physics classes, limited resources and infrastructure, and ineffective teaching methods. These issues are pronounced particularly in Delta State, where educational disparities and varying teaching methodologies can significantly impact student outcomes.Experience, observation, and research (Freeman, Eddy, McDonough, S mith, Wender& Dirks, 2014; Chiemeke & Dike, 2019; & Ugwu, Fagbenro & Akano, 2019) have shown that instruction and learning of physics, which requireabilities in critical thinking and active participation of students, are carried out using the lecture method.

The lecture method is a teacher-centered approach in which the instructor presents facts and principles orally. With this approach, the instructor controls the lesson plan and assumes responsibility for organizing the classroom activities in terms of what needs to be done. The majority of the exercises involve the teacher speaking, with the students either passively listening or only minimally participating (Ovuworie & Ajaja, 2024). The traditional lecture-based teaching methods have long been the dominant approach in physics education. While lectures can effectively convey theoretical knowledge, they often fail to engage students actively or promote deep understanding. Research has shown that passive learning environments can lead to disengagement, resulting in lower retention rates and academic achievement (Freeman et al., 2014). Consequently, there is a growing need to explore alternative instructional strategies that enhance student engagement and learning outcomes.Teaching methods or instructional strategies that are learner-centered, in line with the principles of learning by doing, and promote students'

critical thinking skills and active participation in the construction and organization of knowledge should, therefore, be used for the teaching of physics. This can motivate and facilitate students' learning and comprehension. Such methods enable easy understanding of theories and concepts of physics, which may lead to high achievements of students in physics. Amongst such instructional strategies are experiential learning and brainstorming instructional strategies, or methods.

Experiential Learning Instructional Strategy (ELIS) is a learner-centered teaching approach that emphasizes learning through direct experience, active participation, reflection, and application of knowledge to real-life situations. It refers to a systematic teaching approach in which learners actively engage in concrete experiences, reflect on those experiences, conceptualize new ideas, and apply the acquired knowledge to solve problems, particularly in science and mathematics education. Experiential learning means learning from experience or learning by doing. Okafor (2014) defined experiential learning as knowledge, skills, and abilities attained through observation and simulation. Experiential education first immerses learners in an experience and then encourages reflection about the experience to develop new skills, new attitudes, or new ways of thinking (Schwartz, 2012). According to Ashley (2014), the experiential learning instructional strategy is concerned with connecting real-life practices to learning through the process of reflection. The author noted that the philosophy of experiential instruction is based on the saying that "What I hear, I forget; what I see, I remember; what I do, I understand. This strategy, when utilized, promotes learning through real-life activities.

Experiential learning instructional strategy is important in the sense that it reduces the abstractness of concepts, thereby making them clearer in such a way that it creates opportunities for students to experience certain phenomena by being involved in every necessary step. Through the use of an experiential learning strategy, the objectives and goals of Physics education may be achieved, because as students experience certain phenomena, they will be exposed to certain knowledge in a real-life situation. It is distinct from rote or didactic learning, in which the learner plays a comparatively passive role. It is related to, but not synonymous with, other forms of active learning such as action learning, adventure learning, free-choice learning, cooperative learning, service learning, and situated learning (Clark & White, 2010). The stages involved can be taken into consideration using Kolb's (1984) cycle of experiential learning as a framework. According to Moon's (2004) explanation of this cycle, experiential learning works best when it includes three stages: 1) a reflective learning phase; 2) a learning phase that comes from the acts that are a part of experiential learning; and 3) an additional learning period that comes from feedback. The individual's judgment, feelings, or skills may change as a result of this learning process, which can also give guidance for "making judgments as a guide to choice and action.

Another learner-centered teaching strategy that may also enhance physics students' achievement is the brainstorming instructional strategy (BIS). The brainstorming instructional strategy is a teaching approach that encourages students to generate a wide range of ideas freely and collaboratively in response to a problem, question, or concept presented by the teacher. During brainstorming sessions, students are encouraged to express ideas without criticism, thereby promoting creativity, active participation, and critical thinking. It refers to a structured instructional technique in which learners work individually or in groups to generate, share, and refine ideas related to a given instructional task, to enhance understanding, problem-solving skills, and academic achievement. Using a brainstorming technique, teachers can come up with multiple ideas to assist in solving a specific problem. Several students use it as a cooperative technique in

the classroom, where they all present and discuss their ideas before coming to a consensus on a solution (Mohammad, 2016).

The brainstorming instructional strategy is used to describe a group process of creative problem-solving where a group of 4-6 students is brought together in the classroom and presented with a simple, familiar, and talkable topic, one whose analysis does not require pencil and paper. Sometimes this problem is provided during the group session, while other times it is presented before the meeting to allow members time to consider it. The brainstorming technique focuses on what and how students should learn (Odoh, 2013). Brainstorming instructional strategy has five (5) sequential steps. These are: Introducing the brainstorming rules, Stating the subject or problem, expressing ideas, exhibiting ideas for combination and improvement, and evaluating ideas. The goal of brainstorming is to get the brain to think about problems in a different way. It pushes students to embrace spontaneity, creativity, and imagination in place of traditional, rational thinking. Participants in a brainstorming session swiftly and spontaneously share their thoughts or proposals in response to a single, particular problem or question, without much thought or consideration. Criticism and censorship are prohibited; free interaction and expanding on the ideas of others are encouraged. The objective is to produce as many ideas as possible in a short amount of time, with an emphasis on quantity rather than quality.

For the teaching of science to be effectively and efficiently carried out, science teachers must shift from the predominant method of teaching to the constructivist learning strategies, where the learning is not centered on the teacher but on the students, using their existing knowledge to solve the problems presented to them by the teachers, for students' academic achievements to be improved. Academic achievement is the product of the extent to which educational or instructional goals and objectives have been attained. Academic achievement, according to Nwanze (2016), is the result of learning that indicates how well the goals of education have been realized. Similarly, academic achievement can also be said to be students' achievement in a school subject as designated by a score or mark obtained in a standard test. It is pertinent to note that good academic standing transcends gender boundaries, offering equal benefits to all.

Gender in this study refers to the state of being male or female. It is the characteristics by means of which people define male or female. It refers to the social meaning associated with being a male or a female, including the construction of identities, expectations, behaviour, and power relationships derived from social interaction (Ambe-Uva, Iwachukwu & Jubrin, 2008). Gender is among the variables empirically reported to influence students' achievement in science subjects. While some studies have proven that male students performed significantly better than their female counterparts (Effiom & Abdullahi, 2021), others have shown that female students performed better than their male counterparts (Ademola & Nadaraj, 2018). However, studies have equally revealed no significant difference in the mean achievement and retention scores of male and female students (Umar, Ossom & Egbita, 2021). This shows that studies on how students' gender influences achievement are inconclusive. Therefore, one of the rationales of this study is to determine if experiential learning, brainstorming, and the lecture methods affect male and female students' achievement in Physics differently.

A thorough examination of these instructional strategies (experiential learning, brainstorming, and the lecture method) shows that these methods differ in their principles of presentation of content to be learned. Based on these differences, it becomes necessary to

determine if there will be differences in students' achievement when exposed to the various methods. It is against this background, therefore, that this study compared the effects of experiential learning, brainstorming, and lecture methods on students' achievement in Physicsand also determined whether they are gender-dependent in order to isolate and recommend the most effective methods among them.

Statement of the Problem

The West African Examinations Council (WAEC) reports from 2019–2024on students' performance in Physics have shown some concerning trends. According to various studies and reports, students' performance in Physics has been declining over the years. For instance, the Chief Examiner's Report from WAEC on Senior School Physics showed that candidates performed marginally or poorly in Physics. This poor achievement of students in Physics is worrisome because it will, in turn, hurt other professions like Engineering, Geosciences, Pharmacy, Medicine, Astronomy, and others in terms of manpower. The WAEC Chief examiner reports further indicated that students' weaknesses as to why they achieved poorly include, but are not limited to, their inability to recall and apply correct formulas to solve problems, plot graphs when values are negative, and present graphs with appropriate scales. The abysmal achievements as a result of these weaknesses have been attributed to teaching methods, teacher characteristics, and availability of laboratory facilities, among other factors. Most teachers prefer the lecture method in teaching, maybe because it is easier to implement compared to other teaching strategies that encourage active learning in students. For students to achieve high results, the teacher must use teaching methods that will enable the students to participate actively during learning, reason logically, and also link the lesson to true-life phenomena. It is assumed that experiential learning and brainstorming strategies ensure active participation of students irrespective of gender and better academic achievement during the teaching and learning of Physics. Consequently, the statement of the problem of this study, therefore, is: Will the use of experiential learning and brainstorming instructional strategies improve students' achievement in Physics more than the lecture method in Delta State?

Research Questions

1. What is the difference in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and lecture methods?
2. What is the difference in the mean achievement scores of male and female students taught Physics using an experiential learning instructional strategy?
3. What is the difference in the mean achievement scores of male and female students taught Physics using the brainstorming instructional strategy?
4. What is the interaction effect of teaching strategies and gender on students' achievement in Physics?

Hypotheses

The following hypotheses, tested at 0.05 guided the study:

1. There is no significant difference in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and lecture methods.
2. There is no significant difference in the mean achievement scores of male and female students taught Physics using experiential learning instructional strategy.
3. There is no significant difference in the mean achievement scores of male and female students taught Physics using brainstorming instructional strategy.

4. There is no significant interaction effect of teaching strategies and gender on students' achievement in Physics.

Methodology

Research Design

The study employed the pretest, posttest, and delayed posttest planned variation design. Intact classes were randomly assigned to the different groups. The study comprised three groups: experiential learning, brainstorming, and lecture groups.

Population of the Study

The population for this study consisted of thirty-nine thousand, nine hundred and four (39,904) Secondary School Two (SS II) Physics students in the four hundred and seventy-four (474) senior secondary schools in the three Senatorial Districts of Delta State, Nigeria.

Sample and Sampling Technique

The sample size for the study comprised two hundred and ninety-two (292) Physics students selected from six public mixed senior secondary schools in Delta State. The three Senatorial Districts were evenly represented in the selection of the six schools. Two schools were selected from each of the Senatorial Districts using a stratified random sampling technique.

Research Instrument

The instrument that was used for data collection in this study was the Physics Achievement Test (PAT), which is made up of two sections, A and B. Section A contains questions on students' bio-data, while section B consists of fifty (50) items of multiple-choice objective tests to measure students' academic achievement in Physics based on the six-week Physics SSII instructional units that were covered.

Validity of the Instrument

Both the face and content validity of the Physics Achievement Test (PAT) were duly determined by experts in Science Education and Measurement and Evaluation.

Reliability of the Instrument

The reliability of the Physics Achievement Test (PAT) was established using the Kuder-Richardson formula 21. Upon administration of the Physics Achievement Test (PAT) and analysis of the data collected, a reliability coefficient value of 0.79 was obtained.

Treatment Procedure

The first stage of the treatment procedure was the assignment of schools into experiential learning, brainstorming, and lecture groups. Before the commencement of treatment (teaching), students in the three groups were pretested with the Physics Achievement Test (PAT) to determine the equivalence of the groups. On completion of treatment, students in the three groups were post-tested. The pretest and posttest scores of the students in the three groups were collated and analyzed.

Method of Data Analysis

The research questions were answered using mean and standard deviation, while the hypotheses were tested using t-test and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

Results Research
Question 1:

What is the difference in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and lecture methods?

Table 1:
Mean and Standard Deviation of Pre-Test and Post-Test Achievement Scores among Students Taught Physics Using Experiential Learning, Brainstorming, and Lecture Method

Group	N	Pretest $\bar{X}$	SD	Posttest $\bar{X}$	SD	$\bar{X}diff$
Experiential	99	29.42	10.54	66.67	5.79	37.25
Brainstorming	97	29.28	10.39	64.58	4.09	35.30
Lecture	96	23.90	8.98	55.81	5.30	31.91

Table 1 presents the mean and standard deviation of pre-test and post-test achievement scores of students taught Physics using experiential learning, brainstorming, and the lecture method. At the pre-test stage, students in the experiential learning group ($\bar{X}$ = 29.42, SD = 10.54) and the brainstorming group ($\bar{X}$ = 29.28, SD = 10.39) recorded very similar mean scores, indicating that the two groups were comparable in Physics achievement before treatment. The lecture group, however, had a slightly lower pre-test mean score ($\bar{X}$ = 23.90, SD = 8.98), suggesting a lower initial achievement level. At the post-test stage, all three groups showed marked improvement in their mean achievement scores, indicating that learning occurred across the instructional strategies. Students taught using the experiential learning strategy recorded the highest post-test mean score ($\bar{X}$ = 66.67, SD = 5.79), followed by those taught using the brainstorming strategy ($\bar{X}$ = 64.58, SD = 4.09). Students exposed to the lecture method had the lowest post-test mean score ($\bar{X}$ = 55.81, SD = 5.30). The mean gain scores ($\bar{X}$diff) further highlight the effectiveness of the instructional strategies. The experiential learning group recorded the highest mean gain (37.25), followed closely by the brainstorming group (35.30), while the lecture method produced the least mean gain (31.91)

Hypothesis One:
There is no significant difference in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and lecture methods.

Table 2:
ANCOVA Comparison of the Achievement Scores of Students Taught Physics Using Experiential Learning, Brainstorming, and Lecture Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6434.051[a]	3	2144.684	81.851	.000
Intercept	132754.686	1	132754.686	5066.527	.000
Pretest	6.031	1	6.031	.230	.632
Strategies	6132.134	2	3066.067	117.015	.000
Error	7546.264	288	26.202		
Total	1151108.000	292			
Corrected Total	13980.315	291			

Table 2 indicates that there is a significant difference in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and the lecture method, F (2, 288) = 117.02, P(0.000) < 0.05. Therefore, the null hypothesis is rejected. Thus, significant differences exist in the mean achievement scores among students taught Physics using experiential learning, brainstorming, and lecture methods. Scheffe's post-hoc test in Table3 shows the direction of the difference among the three instructional strategies.

Table 3:
Scheffe's Post-Hoc Analysis Comparison of the Achievement Scores of Students Taught Physics Using Experiential Learning, Brainstorming, and Lecture Method

(I) Instructional strategies	(J) Instructional strategies	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Experiential learning	Brainstorming	2.091*	.731	.005	.652	3.531
	lecture	10.934*	.752	.000	9.454	12.414
Brainstorming	Experiential learning	-2.091*	.731	.005	-3.531	-.652
	lecture	8.843*	.755	.000	7.357	10.328
Lecture	Experiential learning	-10.934*	.752	.000	-12.414	-9.454
	Brainstorming	-8.843*	.755	.000	-10.328	-7.357

The Scheffe's post-hoc analysis was conducted to determine the specific pairwise differences in Physics achievement scores among students taught using experiential learning, brainstorming, and the lecture method, following the significant ANCOVA result. The comparison between experiential learning and brainstorming shows a statistically significant mean difference of 2.091 in favour of experiential learning (p = .005). The comparison between experiential learning and lecture method showed a much larger and statistically significant mean difference of 10.934in favour of experiential learning (p = .000). Similarly, the comparison between brainstorming and the lecture method showed a statistically significant mean difference of 8.843 in favour of brainstorming (p = .000).

Research Question Two:
What is the difference in the mean achievement scores of male and female students taught Physics using experiential learning instructional strategy?

Table 4: Mean and Standard Deviation of Posttest Mean Achievement Scores of Male and Female Students Taught Physics with Experiential Learning Strategy

Sex	**N**	$\bar{X}$	**SD**	$\bar{X}$**diff**
Male	34	67.56	6.72	1.36
Female	65	66.20	5.23	

Table 4 presents the mean and standard deviation of post-test achievement scores of male and female students taught Physics using the experiential learning strategy. The table indicates that

male students recorded a mean achievement score of 67.56 with a standard deviation of 6.72, while female students recorded a mean achievement score of 66.20 with a standard deviation of 5.23. The mean difference of 1.36 slightly favours male students, suggesting that male students performed marginally better than their female counterparts.

Hypothesis Two:
There is no significant difference in the mean achievement scores of male and female students taught Physics using experiential learning instructional strategy.

Table 5:
T-test Comparison of Posttest Mean Achievement Scores of Male and Female Students Taught Physics with Experiential Learning Strategy

Sex	N	$\bar{X}$	SD	df	t_{cal}	Sig. (2-tailed)	Remark
Male	34	67.56	6.72	97	1.11	0.27	Not Significant
Female	65	66.20	5.23				

P > 0.05

Table 5 indicates no significant difference between the posttest mean achievement scores of male and female students taught Physics using experiential learning strategy. This is because the calculated significance value of 0.27is greater than the critical significance value of 0.05. Therefore, the null hypothesis is not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students in Physics using experiential learning instructional strategy.

Research Question Three:
What is the difference in the mean achievement scores of male and female students taught Physics using a brainstorming instructional strategy?

Table 6:
Mean and Standard Deviation of Posttest Mean Achievement Scores of Male and Female Students Taught Physics with Brainstorming Instructional Strategy

Sex	N	$\bar{X}$	SD	$\bar{X}$ Difference
Male	39	64.36	4.30	0.36
Female	58	64.72	3.96	

Table 6 presents the mean and standard deviation of post-test achievement scores of male and female students taught Physics using the brainstorming instructional strategy. The Table indicates that male students had a mean achievement score of 64.36, with a standard deviation of 4.30, while female students had a mean achievement score of 64.72, with a standard deviation of 3.96. The difference between the mean achievement scores of male and female students is 0.36.

Hypothesis Three:
There is no significant difference between the mean achievement scores of male and female students taught Physics using a brainstorming instructional strategy.

Table 7: T-test Comparison of Posttest Mean Achievement Scores of Male and Female Students Taught Physics with Brainstorming Instructional Strategy

Sex	N	$\bar{X}$	SD	df	t_{cal}	Sig. (2-tailed)	Remark
Male	39	64.36	4.30	95	0.43	0.67	Not Significant
Female	58	64.72	3.96				

P > 0.05

Table 7 indicates no significant difference between the posttest mean achievement scores of male and female students taught Physics using the brainstorming instructional strategy. This is because the calculated significance value of 0.67 is greater than the critical significance value of 0.05. Therefore, the null hypothesis is not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students in Physics using the brainstorming learning instructional strategy.

Research Question 4:
What is the interaction effect of teaching strategies and sex on students' achievement in Physics?

Table 8:
Mean and Standard Deviation of the Interaction Effect between Teaching Strategies and Gender on Physics Students' Achievement

Group	Gender	N	$\bar{X}$	SD
ELIS	Male	34	67.56	6.72
	Female	65	66.20	5.23
	Total	**99**	**66.67**	**5.79**
BIS	Male	39	64.36	4.30
	Female	58	64.72	3.96
	Total	**97**	**64.58**	**4.09**
LM	Male	33	57.55	5.92
	Female	63	54.90	4.74
	Total	**96**	**55.81**	**5.30**

Table 8 shows the nature of the interaction between teaching method and gender on Physics students' achievement. The Table shows that the male Physics students taught with ELIS had a mean achievement score of 67.56with a standard deviation of 6.72, while the female students had a mean score of 66.20 with a standard deviation of 5.23. The total mean score for all the students in ELIS is 66.67. For BIS, the male Physics students had a mean achievement score of 64.36 with a standard deviation of 4.30, while the female students had a mean score of 64.72 with a standard deviation of 3.96. The total mean score for all the students in BIS is 64.58.For the lecture method, the male students had a mean achievement score of 57.55 with a standard deviation of 5.92, while the female students had a mean achievement score of 54.90 with a standard deviation of 4.74. The total mean score for all the students in LM is 55.81. This shows that there is an interaction effect. To determine if the interaction effect is significant, the ANCOVA statistic was used to test the hypothesis.

Hypothesis 4:
There is no significant interaction effect of teaching strategies and sex on students' achievement in Physics.

Table 9: ANCOVA Summary on the Effect of Interaction between Sex and Teaching Method on Physics Students' Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6631.538[a]	6	1105.256	42.864	.000
Intercept	131053.726	1	131053.726	5082.521	.000
Pretest	8.177	1	8.177	.317	.574
Strategies	5346.384	2	2673.192	103.672	.000
Sex	100.079	1	100.079	3.881	.050
Strategies * Sex	103.483	2	51.741	2.007	.136
Error	7348.777	285	25.785		
Total	1151108.000	292			
Corrected Total	13980.315	291			

Table 9 shows that there is no significant interaction effect of methods and gender on Physics students' achievement. This is based on the fact that the calculated significant value of 0.136 is greater than the critical significant value of 0.05 ($P > 0.05$). Therefore, Hypothesis 4 is not rejected.

Discussion of Results

The study's first finding showed that there is a significant difference in the mean achievement scores among students taught Physics using ELIS, BIS, and the LM. The Scheffé post-hoc results clearly indicate that all three instructional strategies differ significantly in their effects on students' Physics achievement. ELIS is the most effective strategy, followed by BIS, while LM is the least effective. ELIS yielded a significantly higher achievement score in Physics than the BIS and LM. This may be predicated on the fact that, though the two instructional methods, ELIS and BIS, ensure learners' active participation in the teaching and learning process, ELIS offers students the opportunity to carry outa variety of hands-on activities in the course of learning. This may have accounted for the significantly higher achievement scores of the ELIS group over the BIS and the LM groups, where students have to learn through reasoning alone, and students have been passive in the teaching and learning process, respectively. The highly significant achievement of students taught Physics using ELIS and BIS over those taught using the LM, as found in this study, agrees with the findings of Okoli and Abonyi (2014), who reported that ELIS is superior to the conventional LM in enhancing students' achievement in Physics. This finding, again, aligns with that of Salah (2016), who reported that the BIS was significantly better than the LM in the achievement of science courses and the development of scientific thinking.

The second finding of the study showed that there is no significant difference between the mean achievement scores of male and female students taught Physics using ELIS. This implies that ELIS has an equal effect on both male and female students' academic achievement in Physics. The ELIS structure may have minimized gender-related performance differences by promoting equal participation, shared responsibilities, and peer support during learning activities. The absence of significant gender differences aligns with contemporary educational research,

which indicates that when instructional strategies provide equal opportunities for engagement, communication, and hands-on participation, male and female students tend to perform at comparable levels. This finding is consistent with that of Oguneme (2023), who reported that gender does not have any influence on students' academic achievement when ELIS is adopted for teaching.

The third finding of this study again showed that there is no significant difference between the mean achievement scores of male and female students taught Physics using BIS. This implies that male and female students taught Physics using BIS performed about equally. This, also, may be a result of the level of involvement of male and female students in the BIS group. This finding lends credence to that of Filgona, Filgona, Sababa, and Ndatuwong (2016) who reported no significant difference in gender on students' achievement when exposed to content using BIS.

The fourth finding of the study showed that there is no significant interaction effect of teaching strategies and gender on students' achievement in Physics. The nonsignificant interaction effect implies that the differential achievement observed between the instructional groups was due mainly to the teaching method itself and not to any combined effect of gender and method. The findings demonstrate that while instructional method is a strong determinant of academic achievement in Physics, gender alone does not predict achievement, and neither does it interact with method to influence outcomes. This also implies that ELIS and BIS are not dependent on students' gender. This finding of this study agrees with that of Adeyemi and Awolere (2016), who reported no significant interaction effects of teaching strategies and gender on students' achievement in Physics. However, this finding disagrees with that of Adeyemi and Ajibade (2011), who reported a significant interaction effect of method and gender on students' achievement.

Conclusion

Based on the findings of the study, the study concluded that experiential learning and brainstorming instructional strategies enhance students' achievement in Physics more compared to the lecture method. Experiential learning and brainstorming instructional strategies enhance the mean achievement scores of male and female students equally. Furthermore, the study concluded that while instructional method is a strong determinant of academic achievement in Physics, gender alone does not predict achievement, and neither does it interact with method to influence outcomes.

Recommendations

In light of the findings of the study and the conclusion drawn from these findings, it is recommended that Physics teachers should adopt the use of experiential learning instructional strategy in teaching Physics, while brainstorming instructional strategy can be used as an alternative teaching strategy when the use of the experiential learning strategy is not plausible. It is also recommended that the government and educational administrators should furnish schools with relevant educational resources to facilitate the implementation of experiential learning and brainstorming strategies.

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