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Comparative Effects of 7Es and Guided Discovery Learning Strategies On Academic Achievement of Students in Secondary Schools Physics

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Abstract: *The study investigated the effect of 7Es and guided discovery learning strategies on academic achievement of students in secondary school physics in Taraba State, Nigeria. Four research questions and four null hypotheses guided the study. The study adopted a quasi-experimental research design; specifically, the 2x1x2 factorial pretest-posttest design was employed for the study. Intact classes were assigned to both experimental groups (7Es learning and Guided Discovery Learning Strategies); using hat and draw simple random technique and purposive sampling. The total population of the study was 2,048 secondary school two students offering physics. The sample size for the study was 425 SSII students offering physics in Jalingo Education Zone, Taraba State. A research instrument named Physics Students' Achievement Test (PSAT) with reliability coefficient of 0.72 was used for data collection. Kuder-Richardson's formular- 20 (K-R_{20}) statistic was used to determine the reliability coefficients of the instrument. The data collected were analyzed using mean and standard deviations to answer the research questions and Analysis of covariance (ANCOVA) to test the null hypotheses at 0.05, level of significance. Based on the data collected and analysed, the following findings were made among others: F (1, 422) = 2.414; p = 0.121 > 0.05, thus, there was no statistical significant difference in the mean achievement scores of students taught physics using 7Es learning strategy and those taught using guided discovery learning strategy. The findings revealed that both strategies are effective in improving students' achievement in physics. Also, the findings showed that gender had no significant main effect in the study but significant interaction occurred between the strategies and gender. The following recommendations were made in the light of the findings of the study among others: school authorities should ensure that physics teachers are exposed to 7Es and guided discovery learning strategies through seminars or training to improve their inputs during teaching and learning.*
Keywords: 7Es learning strategy; guided discovery learning strategy, achievement in physics, gender, interaction effect.

INTRODUCTION

Physics is a discipline of science that studies matter and energy, as well as their interactions and measurements (Omeodu, 2018). Physics is one of the major science subjects taught in secondary schools in Nigeria. It has contributed so much to the growth and development of the nation. Physics is a core science subject and its teaching and learning involve much of practical activities. This is carried out by students in the laboratory. It provides the foundation for technological development and prepares them for the pursuit of science related courses at higher levels. Physics as a course of study is a very stimulating and rewarding subject, its study prepares the students to obtain the ability of thinking critically and how to solve problems. Physics is mainly the study of matter, motion and energy. Omosewo and Ogunlade (2012) reported that physics education is designed to train the students to acquire proper understanding of the basic principles as well as their applications. Physics is a natural science that involves the study of matter and its motion through space and time, along with related concepts such as energy and force. In other words, it is the phenomenon or system pertaining to the physical aspects.

Physics is an important science subject that makes enormous academic demands on students in its learning. The researcher is of the opinion that the learning of physics is difficult at best and almost impossible at worst. But because of its great importance to science and technology, there is understandably huge

interest in students' achievement in physics. Thus, the background of students' performance in physics has generated a huge deal of discussion for a long time. Most subjects (physics included) offered at secondary school level have some factors which affect the assimilation of students such as learners' interest, attitude and so on. It then means that a decline in the comprehension of physics concepts which underpins the understanding of other fields will result in a gradual decline in the understanding of such fields as agriculture, engineering, medicine and telecommunication. To enhance the study of physics in schools, the contemporary world is shifting focus from teacher-centered instructional strategies to student-centered strategies. This is because teacher-centered methods of teaching do not seem to promote critical thinking skills in students and consequently problem-solving skills, which in turn, lead to improved achievement. Many student-centered methods of teaching abound, such as co-operative learning, collaborative learning, problem-based learning, concept mapping, teachers' creativity fostering behaviour, mind mapping, cognitive analysis, games and simulation which are all considered as active learning methods. Student-centered methods of teaching have numerous advantages for the student in the teaching-learning process.

According to recent studies, physics learners' achievement is declining (Ugwuanyi et al., 2020; Offordile et al., 2021). Teachers' continuous use of antiquated teaching methods has been blamed for the low level of achievement (Adonu et al., 2021). Despite the fact that we live in the 21st century, which is dominated by the use of contemporary technology, this terrible situation still exists. The information and communication technology era of the 21st century has brought significant changes to the way students study in schools. In this century, teachers and students should adopt learners centered approach to enhance teaching and learning. Teachers in the 21st century have access to a wealth of instructional tools for imparting instruction (Kaminski, 2018); which is why the researcher looked into innovative strategies, to improve students' level of achievement.

Academic achievement has been conceptualized by different researchers and scholars in different ways. According to Hassinger and Plourder (2015), academic achievement refers to what the students have learnt and is usually measured through assessment like standardized test, achievement assessment and portfolio assessment. The concept could be referred to as the measure of students' acquisition of certain skills at the end of teaching and learning activities. The purpose of academic achievement is to provide framework of knowing how students fare in schools, to have constant standard to which all students are held and in order to foster improvement in school academic activities/ learning process. Therefore, an improvement in this area of physics education requires further development of the nature and quality of teaching and learning of science especially physics to improve the academic achievement of students. It reveals how well the learners progressed in accomplishing set goals. Academic achievement is the level of attainment, the manifestation of what have been learnt by the learners in a particular subject or discipline.

Academic achievement is important for the successful development of the young people (students) in the society. Students who do well in schools are better able to make the transition into adulthood and to achieve occupational and economic success. Students' efforts in physics education is required to prepare them become useful members of the society and have opportunity to further their education as stated by the Federal Government of Nigeria in her National Policy on Education, (2020). Unfortunately, school certificate achievement trend conducted by the West African Examination Council (WAEC) in physics examinations is consistently low in the past few years and the trend of fluctuating downward results of students' achievements are not encouraging. The consistent poor achievement may be as a result of difficulties in some content areas. WAEC Chief Examiner's Report (2022) pointed out candidates' weaknesses by revealing that most candidates had difficulty in solving problems on mechanics, sound, heat, and electricity. And it is on this fact, of areas of students' weaknesses, which the present research focuses; to consider the topic 'Linear Momentum' under 'Mechanics' in secondary school physics. Linear momentum is a fundamental concept in understanding motion and the relationship between force and mass. It is defined as the product of an object's mass and velocity, and its conservation is a key principle in many physics problems.

In Taraba State, the evidence of low enrolment and mass failure in public examinations (Senior School Certificate Examination) in physics is indicative that poor achievements have consistently been reported in external examinations (West African Examinations Council, 2014-2023). Chief examiner's report of WAEC, 2024, declared that performance of Physics candidates was not significantly different from the previous years. National Examinations Council (2024) chief examiner also reported that core subjects

(Physics inclusive) recorded mass failure with high degree of malpractices. Consequently, the percentage of students' achievement is low. The analysis of students' performance in West African Senior School Certificate Examinations 2014 - 2023, shows that the percentage of candidates who passed Physics at credit level in the last ten years was relatively better in only one year (2018); with an average pass rate of 43.65%. In the other nine years, the percentage at credit level fluctuated below average, varying from 7.88% to 32.60%. This analysis shows poor trends of performance or low achievement in physics for the past ten years; which boils down to investigate the comparism of two innovative strategies such as 7Es and Guided Discovery Learning Strategies.

In this research, the 7Es model is selected since it provides chances for learners to build their knowledge (Febriana et al., 2014). 7E Constructivist Instructional Strategy is the improvement of the 5E Learning Cycle model (Ghaliyah et al., 2015). The cycles of the applied learning model are emphasized in the understanding of the scientific physics concepts and misconception correction. Furthermore, it is also expected to be able to improve the students' memorization process that is focused on knowledge and knowledge transfer (Balta & Sarac, 2016). The learning cycle approach is a strategy that is deemed adequate for students (Olaoluwa & Olufunke, 2015) as it can help them to elaborate their understanding of certain aspects of scientific research (Hodson, 2020; Putra et al., 2018). The learning strategy in the classroom practice focuses on the experience and knowledge of the early learners (Ghaliyah et al., 2015), which is sum, in attaining a well-organized students' concept, an organized procedure is needed. The learning cycle model has been developed from 3E (Exploration, Explanation, Elaboration), 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and 7E (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend). Some studies suggest that the 7Es learning cycle can foster motivation and learning achievement (Febriana et al., 2014; Sumiyati et al., 2016; Ajayi et al. 2019), improve language comprehension (Balta & Sarac, 2016), is sufficient to achieve goals quickly (Bozorgpouri, 2016), improve the ability of mathematical connections (Rawa et al., 2016), and foster conceptual understanding (Nurmalasari et al., 2014).

Some of the likely benefits of the constructivist instructional strategy as viewed by these educationists (Candra & Achmadi, 2017; Marfilinda, 2019) are that, it can help; i) stimulate student to think critically; ii) improve student learning towards better achievement because this instructional strategy prioritizes students experience, it can also form active, critical and creative students; iii) motivate students to be more active and increase curiosity; and iv) train students to learn concepts through experimental activities and so on. Based on the existing problems and considering the advantages of the learning cycle model, the researcher is also interested in conducting research by applying this 7Es constructivist instructional strategy if it can help in understanding of difficult concepts in physics and thereby improving students' achievement and critical thinking. Another constructivism instructional strategy that this study considers for experimentation is Guided Discovery Learning Strategy (GDLS).

Guided discovery learning strategy involves helping the learners to discover certain facts or answers to a given problem. According to Garuma and Tesfaye (2012, as cited in Olorode & Jimoh, 2016), guided discovery strategy is intentional discovery learning through problem solving under teacher supervision. Guided discovery method is a student-centered method in which the learner uses his mental process to mediate, or find out thing for himself often times, learners depend on their teachers to provide all the answers they need, the teacher provides the setting, the structure and the materials and guides students to discover answers to problems. In guided discovery the answer to the problem is already known to the teacher but he/she wants the learner to discover it. The teachers' role in guided discovery is to serve as facilitators of learning in which students are encouraged to be responsible, autonomous and construct their own understanding of each concept (Achor & Bileya, 2022; Olorode & Jimoh, 2016). Guided discovery strategy increases the degree of students' creativity, innovativeness, problem-solving ability, and consequently improves their achievement in both theory and practice (Ozioko, 2015). Students should be given the opportunities to develop, interact, and find out solutions to problems themselves, so that the cognitive development of students in science (physics inclusive) can be improved irrespective of gender.

Gender is the fact of being male or female. Umoru (2016) defines gender as a socio-cultural and psychological dimension of being a male or female. It is a moderating variable of this study. The influence of gender on the dependent variables will be explored. There might have been conflicting reports in respect to gender and performance in science. Umoru (2016) in a study noted that gender is not a significant factor in students' achievement, since there is an improvement in male and female scores.

Boys or girls may retain more or less physics concepts and principles when taught in a science classroom. Gender is also a factor that interacts with achievement; Adebanjo (2014) and Obochi, (2019) in their individual studies have observed that gender issues both on the part of the teacher and the students have been documented to affect academic achievement and some other learning outcomes. In addition, Adebanjo (2014) also linked gender and academic achievement with patterns of behavior. He noted that there are signs of boys being vulnerable to becoming disaffected. He stated further that boys tend to be less careful about rules and more indifferent to being reprimanded. Tyler cited in Okeke (2011) reported that girls retain more than boys in science. They may also retain equally or not been influenced at all in term of gender. Okeke (2011) noted that gender significantly influences the mean retention scores of science students. Gender gap may be reduced in physics achievement, interest and retention; if the students are exposed to optimum learning opportunity. This is in line with Saleh and Subramaniam (2017) who concluded that optimum learning opportunities can close the gap between male and female performance in physics. However, the problem is compounded by the fact that most science educators give masculine outlook to science subjects and some pointed out that gender has no influence rather they achieve equally when given equal opportunity.

This simply implies that learning opportunity requires a shift from conventional strategy of teaching to a suitable pedagogical strategy. This study is concerned with the alarming crisis in relation to the issue of ineffective teaching/learning strategies on students' achievement and critical thinking in science; and gender-friendliness has been a burning issue mostly in difficult concepts in physics. Since many constructivist strategies are acknowledged as best innovative methods for teaching, there is a need to try such innovative teaching strategies to see how gender will influence student's achievement in physics. It is against this background that this research was carried out in order to establish the comparative effect of 7Es and Guided Discovery Learning Strategies on academic achievement of students in secondary schools physics, in Jalingo Education Zone of Taraba State.

Research Questions

The following questions were answered in this study:

1. What is the difference in the mean achievement scores of students taught physics using the 7Es learning strategy and those taught using GDLS?
2. What is the difference in the mean achievement scores of male and female students taught physics using the 7Es learning strategy?
3. What is the difference in the mean achievement scores of male and female students taught physics using GDLS?
4. What is the interaction effect of treatment and gender on students' achievement in physics?

Research Hypotheses

The following null hypotheses were tested at 0.05, level of significance:

1. There is no significant difference in the mean achievement scores of students taught physics using 7Es learning strategy and those taught using GDLS.
2. There is no significant difference in the mean achievement scores of male and female students taught physics using the 7Es learning strategy.
3. There is no significant difference in the mean achievement scores of male and female students taught physics using GDLS.
4. There is no significant interaction effect of treatment and gender on students' achievement in physics

RESEARCH METHODS

The design of this study was quasi-experimental design. Specifically, the 2x1x2 Factorial Pretest-Posttest design was employed for the study. Each two (2) in the design represents a factor. Therefore, factor A: Innovative Strategy, comprising two strategies are 7Es Learning Strategy and Guided Discovery Learning Strategy; and factor B: Gender, comprising two categories are Male and Female. As for the dependent variable which is only academic performance, it is therefore like a constant. This design was adopted because it was not possible to have complete randomization of the respondents to avoid the disruption of school organization (streaming of classes) or so as not to disrupt the already existing setting in the schools.

The total population of the study was 2,048 secondary school two students offering physics from the 40 public secondary schools in Jalingo Education Zone of Taraba State. The population of SSII students offering physics consisted of 1207 male and 841 female. The sample size for the study was 425 SSII students offering physics in Jalingo Education Zone, Taraba State; out of which 248 were males and 177 were females. Simple random sampling using hat and draw technique was used to select Jalingo education zone, out of the ten education zones of Taraba State; as well as selecting eight schools from the education zone. Purposive sampling was also applied to categorize the eight schools into two experimental groups; ensuring that the schools from the two local governments in the education zone are fairly represented in both groups.

The instrument for data collection was Physics Students' Achievement Test (PSAT) consisting fifty (50) items adapted from standardized test conducted by West African Examination Council (WAEC) 2021-2024. All the 50 items on PSAT instrument are based on the topic 'linear momentum' from SS II physics syllabus; which are multiple choice questions in physics, with four (4) options lettered A-D out of which only one is the correct response to the item(s) and other options are distractors. A table of specification developed by the researcher served as guide for the construction of the instrument. The researcher also prepared two sets of lesson plans for six weeks each that were used in teaching during the study. One set of lesson plans is based on 7E's learning strategy which was used for experimental group one, and the other set is based on guided discovery learning strategy and was for experimental group two. The instrument (PSAT including the lesson plans) were validated (content and face validation) by three experts from Faculty of Education, Taraba State University, Jalingo. Based on the comments and suggestions of the experts, corrections and modifications were made on the instrument and lesson plans.

A trial test of the instrument was conducted to determine the appropriateness of the instrument. A secondary school, which is not within the Jalingo education zone, was used for the pilot test. An intact class of 43 students; offering physics from the school (with 23 males and 20 females) were used; and the pilot testing was conducted in a day. The internal consistency reliability of the Physics Students' Achievement Test (PSAT) was determined to be 0.72; using the Kuder- Richardson's formular- 20 (K-R20). This formula is considered appropriate as it is applied to items that have multiple choice options.

An introductory letter for permission was gotten from the College of Postgraduates' Studies, Taraba State University, (through the Department of Science Education) to the authorities of the secondary schools that were involved for the use of their students and teachers for a period of six (6 weeks). The teachers that participated in this study were the regular physics teachers of the selected schools; who graduated with B.Sc. Ed. Physics with a minimum of five years teaching experience and they were trained for four days using a schedule training manual. For the purpose of collecting data for this study, the PSAT instrument was administered in two phases. The first phase is the administration of pre-test (PRE-PSAT) to the students of both experimental groups; which took place a week before the treatment. After pre-tests administration, the students were taught the topics in the unit 'linear momentum', for six (6) weeks in the same intact classes. This is the treatment stage. One set of lesson plan had been written based on 7Es Learning Strategy which was used by the research assistant of the experimental group one, while the other set of lesson plan was prepared based on Guided Discovery Learning Strategy which was used by the research assistant of the experimental group two. The lesson plans were used by the research assistants after being trained by the researcher in the course of the study. The second phase is the administration of post-test (POST-PSAT) to the students of both groups; which came up after the treatment, to determine students' achievement. In order to reduce or minimize the effect of pretests on post-tests, the researcher withdrew all the instrument's items that were used for the study from both the teachers and the students after the pre-test in order to reshuffle the tests' items as well as the options before using it as post-test, since the same students answered or used the same instrument for pre-tests and post-tests, in order to measure physics students' achievement (PSAT). The data collected were analyzed using mean and standard deviations to answer the research questions and Analysis of covariance (ANCOVA) to test the null hypotheses at 0.05, level of significance.

RESULTS

Research Question One

What is the difference in the mean achievement scores of students taught physics using the 7Es learning strategy and those taught using GDLS?

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Table 1: Mean Achievement Scores and Standard Deviations of Students Taught Physics Using 7Es and Guided Discovery Learning Strategies

Strategies	n	PrePSAT Mean	PrePSAT Std.Dev.	PostPSAT Mean	PostPSAT Std.Dev.	Mean Gain
7EsLS	220	7.64	1.63	19.78	3.86	12.14
GDLS	205	7.50	1.64	19.15	3.41	11.65
Mean Difference		0.14		0.63		0.49

Table 1 shows that the postPSAT mean achievement scores of students taught physics using 7Es Learning Strategy is 19.78 with standard deviation of 3.86, while that of those taught using Guided Discovery Learning Strategy is 19.15 with standard deviation of 3.41. The difference between the prePSAT and postPSAT achievement mean scores of 7Es Learning Strategy group is 12.14 and that of the Guided Discovery Learning Strategy group is 11.65. These differences show what were achieved by the two groups. There is also a difference of 0.63 between the postPSAT mean scores of the two groups; which is in favour of the 7Es Learning Strategy group; with mean gain of 0.49. The implication is that the students taught physics using 7Es Learning Strategy gained in achievement more than their Guided Discovery Learning Strategy counterparts.

Research Question Two

What is the difference in the mean achievement scores of male and female students taught physics using the 7Es learning strategy?

Table 2
Mean Achievement Scores and Standard Deviations of Male and Female Students taught Physics Using 7Es Learning Strategy

	n	PrePSAT Mean	PrePSAT Std.Dev.	PostPSAT Mean	PostPSAT Std.Dev.	Mean Gain
Male	132	7.49	1.56	19.05	4.10	11.56
Female	88	7.83	1.64	20.88	3.20	13.05
Mean Difference		0.34		1.83		1.49

Results of Table 2 show that the postPSAT mean achievement scores of male students taught physics using 7Es Learning Strategy is 19.05 with standard deviation of 4.10, while that of the female students is 20.88 with standard deviation of 3.20. The difference between the prePSAT and postPSAT mean scores of the male students is 11.56 and that of the female students is 13.05. These differences show what were achieved by the male and female students. The difference between the postPSAT mean scores of the two sexes is 1.83 and the mean gained in favour of the female students is 1.49. The implication is that the female students taught physics using 7Es Learning Strategy gained in achievement more than their male counterparts.

Research Question Three

What is the difference in the mean achievement scores of male and female students taught physics using GDLS?

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Table 3
Mean Achievement Scores and Standard Deviations of Male and Female Students Taught Physics Using Guided Discovery Learning Strategy

Gender	n	PrePSAT		PostPSAT		Mean Gain
		Mean	Std.Dev.	Mean	Std.Dev.	
Male	1167.34		1.56	19.26	3.18	11.92
Female	89 7.71		1.73	19.01	3.70	11.30
Mean Difference	0.37			0.25		0.62

Results of Table 3 show that the postPSAT mean achievement scores of male students taught physics using Guided Discovery Learning Strategy is 19.26 with standard deviation of 3.18, while that of the female students is 19.01 with standard deviation of 3.70. The difference between the prePSAT and postPSAT mean scores of the male students is 11.92 and that of the female students is 11.30. These differences show what were achieved by the male and female students. The difference between the postPSAT mean scores of the two sexes is 0.25 and the mean gained in favour of the male students is 0.62. The implication is that the male students taught physics using Guided Discovery Learning Strategy gained in achievement more than their female counterparts.

Research Question Four

What is the interaction effect of treatment and gender on students' achievement in physics?

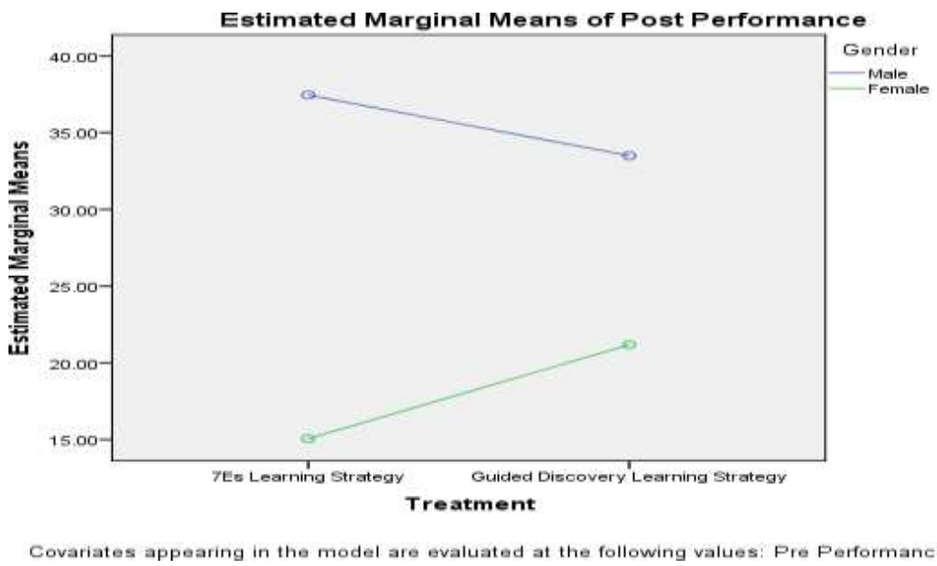

Figure 1: Interaction Effect of Treatment and Gender on Students' Achievement in Physics

In Figure 1, the profile plot/graph shows the interaction effect of treatment and gender on students' achievement in physics. The interaction pattern shows that the plots for male and female do not intersect and are far apart, though not parallel lines for 7Es and Guided Discovery learning strategy learning strategies. This indicates that there is likelihood of an interaction effect of treatment and gender on students' achievement in physics when the plot is extrapolated. The intersection could only be at infinity, which means that the interaction effect between treatments and gender may be tenable in this case.

Hypothesis One

There is no significant difference in the mean achievement scores of students taught physics using 7Es learning strategy and those taught using GDLS.

Table 4

One-way Analysis of Covariance of the Mean Achievement Scores of both Experimental Groups

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	artial Eta Squared
Corrected Model	1061.732[a]	2	530.866	48.529	.000	.187
Intercept	2852.862	1	2852.862	260.795	.000	.382
PrePSAT	1019.534	1	1019.534	93.201	.000	.181
Group	**26.407**	**1**	**26.407**	**2.414**	**.121**	**.006**
Error	4616.306	422	10.939			
Total	166914.000	425				
Corrected Total	5678.038	424				

Table 4 is one-way ANCOVA between groups analysis of covariance to compare the effect of 7Es learning strategy and guided discovery learning strategy on students' achievement in Physics. The result F (1,422) = 2.414, P = 0.121 > 0.05 shows that the two groups do not differ significantly. Thus, the null hypothesis is retained. Therefore, there is no significant difference between the mean achievement scores of students taught physics using 7Es learning strategy and those taught using guided discovery learning strategy. The effect size (eta square = .006) is very low and it indicates that 0.6 % of the mean achievement score of students was accounted for by the strategy used.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female students taught physics using the 7Es learning strategy**.**

Table 5

One-way Analysis of Covariance of the Mean Achievement Scores of Male and Female Students taught Physics using 7Es Learning Strategy

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	762.062[a]	2	381.031	33.001	.000	.233
Intercept	1398.463	1	1398.463	121.122	.000	.358
EXP1-PrePSAT	586.788	1	586.788	50.822	.000	.190
EXP1-Gender	**109.289**	**1**	**109.289**	**9.466**	**.002**	**.042**
Error	2505.466	217	11.546			
Total	89358.000	220				
Corrected Total	3267.527	219				

Table 5 is one-way ANCOVA between gender analysis of covariance to compare the effect of 7Es learning strategy on male and female students' achievement in Physics. The result F (1, 217) = 9.466, P = .002 < 0.05 shows that there is variation of scores for male and female students, of 7Es learning strategy group. Thus, the null hypothesis is not retained. Therefore, there is a statistically significant difference between the mean achievement scores of male and female students taught physics using 7Es learning strategy. The effect size (eta square = .042) is small and it indicates that 4.2 % of the mean achievement score of students can be attributed to gender of the experimental group one.

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Hypothesis Three

There is no significant difference in the mean achievement scores of male and female students taught physics using GDLS.

Table 6

One-way Analysis of Covariance of the Mean Achievement Scores of Male and Female Students taught Physics using Guided Discovery Learning Strategy

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	396.357[a]	2	198.178	20.301	.000	.167
Intercept	1481.246	1	1481.246	151.734	.000	.429
PrePSAT	393.275	1	393.275	40.286	.000	.166
Gender	**15.405**	**1**	**15.405**	**1.578**	**.210**	**.008**
Error	1971.955	202	9.762			
Total	77556.000	205				
Corrected Total	2368.312	204				

Table 6 is one-way ANCOVA between gender analysis of covariance to compare the effect of guided discovery learning strategy on male and female students' achievement in Physics. The result F (1, 202) = 1.578, P = .210 > 0.05 shows that there is no variation of scores for male and female students, of guided discovery learning strategy group. Thus, the null hypothesis is retained. Therefore, there is no statistically significant difference between the mean achievement scores of male and female students taught physics using guided discovery learning strategy. The effect size (eta square = .008) is very small and it indicates that 0.8 % of the mean achievement score of students can be attributed to gender of the experimental group two.

Hypothesis Four

There is no significant interaction effect of treatment and gender on students' achievement in physics.

Table 7

ANCOVA of Interaction Effect of Treatment and Gender on Students' Achievement in Physics

Dependent Variable: Post Performance

Source	ype III Sum of Squares	df	Mean Square	F	Sig.	artial Eta Squared
Corrected Model	32997.761[a]	4	8249.440	93.349	.000	.471
Intercept	24664.914	1	24664.914	279.104	.000	.399
Prep	274.302	1	274.302	3.104	.079	.007
Treatment	121.567	1	121.567	1.376	.242	.003
Gender	30215.042	1	30215.042	341.909	.000	.449
Treatment * Gender	**2472.197**	**1**	**2472.197**	**27.975**	**.000**	**.062**
Error	37116.122	420	88.372			
Total	411200.000	425				
Corrected Total	70113.882	424				

a. R Squared = .471 (Adjusted R Squared = .466)

Table 7 is two-way ANCOVA of interaction effect of treatment and gender on students' achievement in physics. After adjusting the mean for the pre-PSAT scores, the result F (1, 420) = 27.975, P = .000 < 0.05 shows that there was significant interaction effect of treatment and gender on students' achievement in physics. Hence, the null hypothesis is rejected. Also, the effect size (eta square = .062) is low; which indicates that only 6.2 % of the mean achievement score was due to the interaction effect of treatment and gender.

DISCUSSION OF FINDINGS

Finding on students' achievement using of 7Es and guided discovery learning strategies revealed a difference of 0.63 between the postPSAT mean scores of the two groups; which is in favour of the 7Es

Learning Strategy group; with mean gain of 0.49. There was no significant difference between the mean achievement scores of students taught physics using 7Es learning strategy and those taught using guided discovery learning strategy. This implies that the students taught physics using 7Es Learning Strategy gained in achievement more than their Guided Discovery Learning Strategy counterparts. The finding agrees with Villacrusis and Beloy (2021) that there is no significant difference between the posttest scores of the experimental and control groups. However, the finding disagrees with Namani and Yusuf (2025) that there is significant difference in the mean score of academic performance of biology students exposed to guided discovery strategy and those exposed to conventional lecture method. The finding disagrees with Saleh et al. (2025) that G.D.M. as a method of teaching was a significant factor of students' interest and achievement in chemistry. The finding disagrees with Abubakar et al. (2024) that students' achievement in learning Basic Science and Technology was dependent on the teaching method used. The finding disagrees with Danjuma and Nkumsar (2024) that there is significant difference between the mean performance scores of students taught Genetics using 7Es instructional Strategy and those taught same concept using 3Es instructional Strategy in favor of 7Es instructional Strategy.

The finding disagrees with Ubom et al. (2024) that students taught Basic Science using the guided discovery method had significantly higher academic achievement than those taught with conventional methods. The finding disagrees with Tofi et al. (2022) that there was a significant difference between the mean academic performance scores of students taught biology using guided discovery method and those taught using lecture method. The finding disagrees with Kosobameji (2022) that the 7E instructional approach is superior to the lecture method. The finding disagrees with Adolphus et al. (2021) that there was statistical significant improvement in student's achievement in chemical equilibrium after exposure to 7E's instructional approach compare to cooperative strategy. The finding disagrees with Cherono (2021) that students in the experimental group performed better than students in the control group. The finding disagrees with Abdullahi et al. (2021) indicated a significant value of $p < 0.05$ for the achievement variable. The finding disagrees with Libata et al. (2021) that the experimental group students evidenced more learning achievements and retention of information than the control group students. The finding disagrees with Nilda (2021) that there is a significant difference between the academic achievement of learners who had undergone traditional instruction approach and academic achievement of learners who had undergone 7E model inquiry-based approach.

The finding disagrees with Muhammad and Farkhunda (2020) that the experimental group outscored significantly than control groups on post-test as well as on retention test exhibiting the effectiveness of the 5E instructional model. The finding disagrees with Adak and Chatterjee (2019) that the students exposed to the constructivist 7E-model significantly achieved better than traditional method. The finding disagrees with Dajal and Mohammed (2019) that there was significant difference between the mean achievement scores of experimental group and control group. The finding disagrees with Maskur et al., (2019) that the use of the 7E Learning Cycle model is sufficient to improve the learners' understanding of temperature and heat concepts. The finding disagrees with Naade et al., (2018) that there was statistically significant difference between the mean scores of those exposed to 7Es' constructivist approach and those exposed to the traditional method. The finding disagrees with Akani (2017) that guided discovery instruction strategy was more effective than the conventional method in promoting chemistry students' achievement. The finding disagrees with Kure (2017) that there was significant difference in the mean achievement scores among experimental groups and control group. The finding disagrees with Khaled (2016) that the 7E's Learning Cycle is more effective than the traditional method on the immediate and delayed mathematical concepts achievement. The finding disagrees with George (2016) that the Constructivist 7-E model is more effective than the traditional method of teaching Geography at Secondary School level; thereby improving the achievement level of the students. The finding disagrees with Datom (2015) that out of the three methods of teaching tested, guided discovery method (EG2) performed best.

The adoption of 7Es learning strategy in the present study provides a comprehensive instructional model that accommodates various instructional approaches. It helps for exploration of students' beliefs and construction of new knowledge by them, while discarding their misconceptions, through their thought processes. The adoption of 7Es learning strategy in the present study also affords the teacher the ability to display his teaching dexterity by responding to students' conceptions or lack thereof and seizing those moments during teaching to capitalize on promoting conceptual understanding. This may be responsible for the no significant difference found in the mean achievement scores of students taught physics using

7Es and guided discovery learning strategy.

The use of Guided Discovery Learning Strategy (GDLS) gives the teacher opportunities for an activity-oriented learning process in Physics classroom. The teachers uses guided discovery learning strategy as an approach to teaching in which students are guided by the teacher to find facts by themselves. The adoption of guided discovery learning strategy provides opportunity for students to investigate, use their discretion, contribute to knowledge, and get information individually or collectively; with the attempt to find solution(s) to a given task. This may be responsible for the no significant difference found in the mean achievement scores of students taught physics using 7Es and guided discovery learning strategy.

Finding on students' achievement with reference to gender using of 7Es learning strategy revealed that the difference between the postPSAT mean scores of the two sexes is 1.83 and the mean gained in favour of the female students is 1.49. There was a statistically significant difference between the mean achievement scores of male and female students taught physics using 7Es learning strategy. This connotes that the female students taught physics using 7Es Learning Strategy gained in achievement more than their male counterparts. The finding agrees with Adolphus et al. (2021) that male students performed better than female students exposed to 7E's instructional approach. However, the finding disagrees with Abubakar et al. (2024) that the 7Es instructional strategy was not gender bias; both the male and female students had the same level of achievement in Basic Science and Technology with the aid of 7Es instructional strategy. The finding disagrees with Kosobameji (2022) that gender does not have an effect on the achievement of students when taught using the 7E instructional approach.

Gender stereotyping permeates students' achievement when 7Es learning strategy was used in physics class. The presents study found that the use of 7Es learning strategy is gender sensitive with reference to students' achievement in Physics. There was significant difference in the mean achievement scores of male and female students taught physics using 7Es learning strategy. This is because 7Es learning strategy first determine what the students already know about the concept to be taught. The 7Es learning strategy enables students to present their own ideas, creativity and transfer the knowledge with reference to gender.

Finding on students' achievement with reference to gender using of guided discovery learning strategy revealed that the difference between the postPSAT mean scores of the two sexes is 0.25 and the mean gained in favour of the male students is 0.62. There was no statistically significant difference between the mean achievement scores of male and female students taught physics using guided discovery learning strategy. This implies that the male students taught physics using Guided Discovery Learning Strategy gained in achievement more than their female counterparts. The finding agrees with Tofi et al. (2022) that there was no significant difference between the mean academic performance scores of male and female students taught biology using guided discovery method. The finding agrees with Saleh et al. (2025) that gender was not a significant factor of the achievement of students in chemistry. The finding agrees with Dajal and Mohammed (2019) that there was no significant difference between the mean achievement scores of male and female students in the experimental group.

Gender stereotyping permeates students' achievement when guided discovery learning strategy was used in physics class. The presents study found that the use of guided discovery learning strategy is gender friendly with reference to students' achievement in Physics. There was no significant difference in the mean achievement scores of male and female students taught physics using 7Es learning strategy. This is because the use of guided discovery learning strategy enables students to discuss the subject matter and to actively engage in its exploration, allows learners to use process skill to generate content information and active engagement of learners in first hand real-world learning irrespective of gender.

Finding on students' achievement due to interaction effect of treatment and gender revealed that there was likelihood of an interaction effect of treatment and gender on students' achievement in physics when the plot is extrapolated. There was significant interaction effect of treatment and gender on students' achievement in physics. The finding agrees with Libata et al., (2021) that interactions of and treatment was significant in learning achievement.

CONCLUSIONS

The study has established that there was no significant difference between the mean achievement scores

of students taught physics using 7Es learning strategy and those taught using guided discovery learning strategy. There was a significant difference between the mean achievement scores of male and female students taught physics using 7Es learning strategy. There was no significant difference between the mean achievement scores of male and female students taught physics using guided discovery learning strategy. There was significant interaction effect of treatment and gender on students' achievement in physics. It was concluded that the use of 7Es and guided discovery learning strategies enhance students' achievement and beneficial to students in Physics class. Both the 7Es learning strategy and guided discovery learning strategy are effective in improving students' academic achievement. The study also concludes that the use of 7Es learning strategy is gender sensitive with reference to students' achievement in Physics.

Recommendations

The following recommendations were made in the light of the findings of this study:

1. Physics teachers should be exposed to 7Es and guided discovery learning strategies through seminars or trainings to improve their inputs during teaching and learning by the school authorities.
2. Physics teachers should adopt both the 7Es and guided discovery learning strategies in classroom instruction, since both are effective to enhance students' achievement.
3. Physics teachers should be sensitive to gender differences in learning and adopt flexible teaching practices that encourage equal opportunity, equal participation and benefit for all students.
4. Curriculum planners should incorporate learner-centered (innovative) strategies like 7Es and guided discovery into the curriculum to support active learning.

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