Effects of Polya's Problem-Solving, 7E Learning Cycle and Lecture Methods on Physics Students' Achievement and Retention in Delta State, Nigeria

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ABSTRACT

This study looked at how Polya's problem-solving approach to teaching affected the academic achievement of Physics students in Delta State secondary schools. This study was guided by four research questions and four hypotheses. The pretest, posttest, quasi-experimental design was utilized in this study. Three hundred and eighteen (318) SS II Physics students was the sample size. Three experts validated the Physics Achievement Test (PAT) before it was utilized for data collection. Mean, standard deviation, independent sample t-test and Analysis of covariance (ANCOVA) were used to analyze the acquired data. The result showed that (i) there is a significant differences in the average achievement scores among students instructed with the Polya's problem-solving teaching strategy, 7E learning cycle instruction strategy and lecture method in favor of the Polya's problem-solving teaching strategy; (ii) there is no noteworthy diversity in the average achievement scores of male and female students instructed physics using Polya's problem-solving teaching strategy; (iii) there is no noteworthy diversity in the average achievement scores of male and female students instructed physics using 7E learning cycle teaching strategy and (iv) there is no significant interaction effect of method and sex on Physics students' achievement. It was therefore concluded that Polya's problem-solving instructional strategy is more effective followed by the 7E learning cycle instructional strategy in enhancing Physics students' achievement than the lecture method. Arising from the findings, it is recommended that Physics teachers should adopt the use of Polya's problem-solving instructional strategy in teaching Physics in senior secondary schools.

Keywords: Polya's Problem Solving Strategy, 7E learning Circle, Achievement, Students' Achievement

INTRODUCTION

Education, arguably, is a vital tool for both human and national sustainable development. It is a systematic process of teaching and learning, which culminates into changing the perception of an individual for good. Physics is the bedrock of scientific and technological development of any nation. It deals with physical principles and laws governing the universe and often considered the most utilized science subject in technology-related professions. Friedl (2015) defined Physics as the fundamental science which creates a foundation for other natural sciences. The International Union of Pure and Applied Physics (IUPAP, 1999) defined Physics as the scientific study of matter and energy and their interactions with each other, which plays a key role in the life process of mankind.

Physics is one of the subjects offered in the secondary schools at senior level and the knowledge obtained from Physics is applicable in scientific and technological advancement of any nation, whether developed or developing. The concepts of Physics explain most human physical activities or phenomenon. For example, the concept of gravity in Physics explains why if we jump, we come down; the concept of electricity explains the functionalities of electric bulbs in our homes; the concepts of friction explain why we are able to walk on a rough surface and the tendency to slip on a smooth surface; the concept of heat explains the rise and fall of temperature of our body. Furthermore, the bottom of a clear river or pond which appears shallower than it really 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 shows 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, in Nigeria, despite the glaring importance of Physics in our everyday lives, it has been observed that a lot of students still perceive Physics to be difficult and are really not motivated to study the subject. This has led to the persistent poor academic achievement of students in the subject in examinations particularly external examinations such as the West Africa Senior Secondary Certificate Examination (WASSCE) (WAEC, 2016 - 2019). Over the years, the outcome of the review of the West Africa Examination Council (WAEC) Chief Examiner's annual reports (2016 – 2021) on students' achievement in Physics have shown below average and fluctuating trend in achievement of students in Physics. The reports also indicated that students lack basic understanding of Physics concept which results to their inability to recall and retain information as a result of the teaching method employed by teachers.

Additionally, different research findings such as those of Chiemeke and Dike (2019), Ugwu, Fagbenro and Akano (2019), to mention but a few have also reported the poor achievement of students in Physics. This poor achievement has been attributed to numerous factors by different scholars. Macmillan and Gana (2019) attributed the poor achievement in Physics to inadequate human and material resources. Amuche, Bello and Marwan (2014) also attributed the poor achievement of students in sciences, particularly in Physics to lack of qualified teachers, poor instructional strategies, poor infrastructure, non-availability of standard laboratories and poor utilization of instructional materials. Furthermore, Oladejo, Olosunde, Ojebisi and Isola (2011) attributed the poor and fluctuating achievements of students in Physics to the teacher's instructional strategy which is considered a critical factor.

Consequent upon the above, one common factor identified by researchers as well as the WAEC Chief Examiner to which poor achievement of students in Physics is attributed is the application of inappropriate instructional strategy or methods. Experience and observation have shown that the teaching and learning of Physics which requires critical thinking skills and active participation of students is taught using the lecture method. The lecture method of teaching is considered the oldest method and it involves a one-way channel of communication (Obro, 2023). Students' involvement in this teaching method is just to listen and sometimes take notes if necessary, during the lesson. The teacher clarifies the content to the students by using gestures, simple devices, changing voice, change in position and facial expressions (Obro, 2022). Ajaja (2009) referred to lecture method as an address, a talk, a lesson or other types of verbal presentation to students by a teacher.

Despite the advantages of the lecture method, Science Educators of the years have advocated for innovative and learner-centred methods of teaching science subject. This is because, the lecture method is a teacher or content/subject-centred method making the teacher a reservoir of knowledge, dispensing knowledge to students, who contribute very little or nothing to the instructional process thereby making the students passive learners as opposed to being active participants in terms of teacher-students interaction (Misan-Ruppee, Obro & Akpochafo, 2023), students-students interaction and students' interaction with learning materials. Teaching methods that are learner-centred, in line with the principles of learning by doing, promote students' critical thinking skills and active participation in the construction and organization of knowledge. This can motivate and facilitate students' learning and comprehension. For 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 centred on the teacher but on the students using their existing knowledge to solve the problems presented to them by the teachers in order for students' academic achievements to be improved on. Amongst such methods are the Polya's problem-solving and 7E learning cycle instructional strategies.

The Polya's problem-solving instructional strategy (PPSIS) can be defined as the systematic process of critical thinking of finding a solution to a given problem through understanding of the problem, devising a plan, carrying out the plan, and assessing the results in confirmation of the answer to the problem. Problem solving is a method to develop the ability of mathematical problem solving. This enables the students to become independent discoverer and by this method they can solve daily life problems. Polya's problem-solving instructional strategy is a four sequential step to systematically attain the solution of a mathematical problem. The first step which is understanding the problem can be defined as students understanding the problem with respect to given data or what data is known and unknown with the problem. To facilitate students' understanding of the problem, figures and diagrams may be used and teachers are expected to ask questions. Some of the questions asked by teachers, according to Lindsey (2018), to ascertain that the students have understood the problem are: do you understand all the words used in stating the problem? What are you asked to find or do? Or can you think of a picture or diagram that might help you understand the problem?

The second step is devising a plan to solve the problem. It is the stage where students are encouraged or motivated to search for the relationships or links between the data given, that is, what is known and what is unknown in order to make a resolution plan. This stage provides deeper understanding about the problem. The third step is carrying out the Plan. This is also considered the implementation stage of the strategy. It is the implementation of what has been planned in step two in order to find a solution to the problem. The fourth stage of the strategy is looking back. This is the stage where students have to confirm their solution by applying it in a new situation or thinking whether the resolution steps can be used for other problems. Polya asserted that by looking back, students have to reconsider, re-examine the results and the process of solution for the consolidation of their knowledge and to develop the ability to solve such examples independently in their daily life

The 7E learning cycle instructional strategy (7ELCIS) is another learner-centred method. Its steps, which are interconnected and interrelated include: elicit, engage, explore, explain, elaborate, evaluate and extend. In the elicit phase, the leaners' prior knowledge is prompted to ascertain what they know about a concept to be taught. It is the recall of prior understanding of students about the topic. The students' preceding conception is made evident through questioning (Naade, Alamina & Okwelle, 2018). In the engagement phase, learners' attention on what is to be learnt are captured. The topic is presented in a way that is exciting to the students. This is achieved through the use of short activities that stimulate their thinking, thereby increasing their interest and eagerness to learn new concept. In the exploration phase, students are offered opportunity to examine the topic to be taught or learnt. They observe and record data, isolate variables, design and plan experiments (Eisenkraft, 2003). During this phase, students are involved in solving a problem, task, or situation in an attempt to understand the material on individual bases or in groups. This can enable students identify what they are confused about, where they have conflicting ideas, and the unanswered questions they may have. At the explanation phase, students become more acquainted with new ideas, terms, or ways of thinking. This will be facilitated by the teacher or peer interaction or collaboration where students interact and collaborate in order to attain meaningful understanding of the concept to be taught.

The elaboration phase encourages pupils to expand their intellectual knowledge. In other words, students engage in expansion of whatever understanding they have gotten either from the explanation of the teacher or through peer communication or cooperation. This phase inspires pupils to learn more and conduct additional research on the subject. The evaluation phase gives students a chance to review or evaluate what they have learned through assignments or tests that demonstrate a sufficient understanding of the material. Also, the teacher assesses learners' conceptual understanding both formatively and summatively. Lastly, the extend phase involves relating a new acquired knowledge to new situations within. In this phase, students apply knowledge in a new context as well as to their everyday life. This phase entails applying the recently learned information and abilities to brand-new circumstances in the field.

Academic achievement basically is the product of the extent to which educational or instructional goals and objectives have been attained. Academic achievement is the performance outcomes that depicts the extent to which a learner has accomplished specific goals that were the focus of activities in instructional environments such as educational institutions. Nwanze (2016) defined academic achievement as outcome of learning which expresses the extent to which instructional objectives have been met. Salau (2009) submitted that many researchers have adduced that poor performance in public examination is traceable to teaching techniques by teachers. The resultant effect is the low academic outcome both in internal and external examinations. When learners maintain the knowledge, they have acquired, they have good academic outstanding irrespective of their sex. The study's definition of "sex" is the state of being male or female. It is the characteristics by means of which people define male or female. Sex is one of the factors that have been empirically reported to influence students' achievement in science subjects. While some studies have proven that male students performed noticeably better than their female counterparts (Effiom & Abdullahi, 2021) others have shown that female students performed better than their male counterpart (Ademola & Nadaraj, 2018). However, studies have equally revealed no significant difference in the mean achievement scores of male and female students (Umar, Ossom & Egbita, 2021).

From the x-ray of lecture, Poly's problem solving and 7E learning cycle instructional strategies, it can be seen that these methods differ in their principles of presentation of content to be learned. Based on these differences in the principles of presentation of concepts, it becomes necessary to determine if there will be differences in students' achievement when exposed to the various methods. This study therefore, seeks to compare the effects of Polya's problem-solving, 7E learning cycle and lecture methods on Physics students' achievement and also determine whether they are sex dependent.

Research Questions

1. What is the difference in the mean achievement scores of students taught Physics using Polya's problem-solving instructional strategy, 7E learning cycle instructional strategy and lecture method?
2. What is the difference in the mean achievement scores of male and female students taught Physics using Polya's problem-solving instructional strategy?
3. What is the difference in the mean achievement scores of male and female students taught Physics using 7E learning cycle instructional strategy?
4. What is the effect of interaction between method and sex on Physics students' achievement?

Hypotheses

1. There is no significant difference in the mean achievement scores of students taught Physics using Polya's problem-solving instructional strategy, 7E instructional strategy and lecture method.
2. There is no significant difference in the mean achievement scores of male and female students taught Physics using Polya's problem-solving instructional strategy.
3. There is no significant difference in the mean achievement scores of male and female students taught Physics using 7E learning cycle instructional strategy.
4. There is no significant effect of interaction between method and sex on Physics students' achievement

METHOD

Study Design

This study employed the pretest, posttest, planned variation quasi-experimental design. Sex (male/female), repeated testing (pretest, posttest) and three (3) instructional methods (Polya's problem-solving instructional strategy, 7E learning cycle instructional strategy and lecture method) made up the design.

Population

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

Sample and Sampling Techniques

The study participants included 318 SS II Physics students from six (6) intact classes from six (6) mixed secondary schools. The simple random sampling method of hat and draw technique with replacement was used to choose the six (6) secondary schools.

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Research Instrument

The Physics Achievement Test (PAT) was the instrument utilized to generate data. It was validity by three experts and a table of specifications, respectively. Kuder-Richardson's Formula – 21 (K-R-21) was employed to determine the Physics-Achievement-Test (PAT)'s reliability. A coefficient of 0.86 was found after analysis. Mean, standard deviation, independent sample t-test and Analysis of covariance (ANCOVA) were used to analyze the acquired data.

RESULT

Research Question 1: What is the difference in the mean achievement scores among students taught Physics using Polya's problem-solving instructional strategy, 7E learning cycle instructional strategy and lecture method?

Table 1: Descriptive Statistics of Mean and Standard Deviation Showing the difference at Posttest among Achievement Scores of Students Taught Physics using Polya's Problem-Solving Instructional Strategy, 7E Learning Cycle Instructional Strategy and Lecture Method

Groups	N	$\underline{X}$	SD
PPSIS	136	36.09	4.47
7ELCIS	90	33.51	4.77
LM	92	23.18	5.94

Table 1 shows that at posttest, students taught Physics using PPSIS had a mean score of 36.09 with a standard deviation of 4.47, those taught with 7ELCIS had a mean score of 33.51 with a standard deviation of 4.77, while students taught Physics using lecture method had a mean score of 23.18, with a standard deviation of 5.94. The result indicates that the group exposed to PPSIS achieved higher in posttest scores, followed by the group exposed to 7ELCIS, while the group exposed to lecture method had the least score. The mean scores of the three groups also indicate that there exists a difference in the groups. To examine the significance of this difference, the ANCOVA analysis was used and the results were presented in table 2.

Hypothesis 1: There is no significant difference in the mean achievement scores among students taught Physics using Polya's problem-solving instructional strategy, 7E instructional strategy and lecture method.

Table 2: ANCOVA Comparison of Posttest Scores of Students taught Physics using Polya's Problem-Solving Instructional Strategy, 7E Learning Cycle Instructional Strategy and Lecture Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10102.343[a]	3	3367.448	134.439	.000
Intercept	9581.217	1	9581.217	382.511	.000
Pretest	241.461	1	241.461	9.640	.002
Teaching Methods	9829.948	2	4914.974	196.220	.000
Error	7865.144	314	25.048		
Total	340089.000	318			
Corrected Total	17967.487	317			
a. R Squared = .562 (Adjusted R Squared = .558)					

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Table 2 shows that the calculated F-value for teaching methods was 190.653 and its p-value was 0.000. Since the p-value of 0.000 is less than 0.05 level of significance, F (2,317) = 196.220; p < 0.05, the null hypothesis which states that there is no significant difference in the mean achievement scores of students taught Physics using Polya's problem-solving instructional strategy, 7E instructional strategy and lecture method is rejected. Therefore, there is a significant difference in the posttest mean achievement scores among students taught Physics using Polya's problem-solving instructional strategy, 7E instructional strategy and lecture method.

Research Question 2: What is the difference in the mean achievement scores of male and female students taught Physics using Polya's problem-solving instructional strategy?

Table 3: Descriptive Statistics of Mean and Standard Deviation Showing the difference at Posttest on the Achievement Scores of Male and Female Students taught Physics using Polya's Problem-Solving Instructional Strategy

Sex	**N**	$\underline{X}$	$\underline{X}$ **Diff.**	**SD**
Male	76	36.09	0.01	4.54
Female	60	36.10		4.42

Table 3 shows a posttest mean achievement score of 36.09 with standard deviation of 4.54 for male students taught Physics using Polya's problem-solving instructional strategy, while their female counterpart had a posttest mean achievement score of 36.10 with standard deviation of 4.42. The mean difference between both sexes is 0.01, in favour of the female students. In order to examine the significance of this difference, the t- test statistics was used and the results were presented in table 4

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students taught Physics using Polya's problem-solving instructional strategy.

Table 4: Independent Samples t-test Comparison of Posttest Achievement Scores of Male and Female Students taught Physics using Polya's Problem-Solving Instructional Strategy

Sex	**N**	$\underline{X}$	**SD**	**df**	**t-cal**	**Sig. (2-tailed)**	**Decision**
Male	76	36.09	4.54	134	0.07	.995	**H_{o3} is not rejected**
Female	60	36.10	4.42				

Table 4 shows that the calculated t-value for the difference between the two means was 0.07 and its p-value was 0.995. This indicates that there is no statistically significant difference at the alpha level of significance (α=0.05) between the mean scores of male and female students taught Physics using Polya's problem-solving instructional strategy. Therefore, the hypothesis is not rejected, which indicates that there is no significant difference in the posttest mean achievement scores of male and female students taught Physics using Polya's problem-solving instructional strategy, t(134) = 0.07, p>0.05.

Research Question 3: What is the difference in the mean achievement scores of male and female students taught Physics using 7E learning cycle instructional strategy?

Table 5: Descriptive Statistics of Mean and Standard Deviation Showing the difference at Posttest on the Achievement Scores of Male and Female Students taught Physics using 7E learning cycle instructional strategy

Sex	**N**	$\underline{X}$	$\underline{X}$ **Diff.**	**SD**
Male	43	35.05	1.60	4.67
Female	47	33.45		5.17

Table 5 shows a posttest mean achievement score of 35.05 with standard deviation of 4.67 for male students taught Physics using 7E learning cycle instructional strategy, while their female counterpart had a posttest mean achievement score of 33.45 with standard deviation of 5.17. The mean difference between both sexes is 1.60, in favour of the male students. In order to examine the significance of this difference, the t- test statistics was used and the results were presented in table 6

Hypothesis 3: There is no significant difference in the mean achievement scores of male and female students taught Physics using 7E learning cycle instructional strategy.

Table 6: Independent Samples t-test Comparison of Posttest Achievement Scores of Male and Female Students taught Physics using 7E learning cycle instructional strategy

Sex	**N**	$\underline{X}$	**SD**	**df**	**t-cal**	**Sig. (2-tailed)**	**Decision**
Male	43	35.05	4.67	88	1.535	.128	**H_{o3} is not rejected**
Female	47	33.45	5.17				

Table 6 shows that the calculated t-value for the difference between the two means was 1.535 and its p-value was 0.128. This indicates that there is no statistically significant difference at the alpha level of significance (α=0.05) between the mean scores of male and female students taught Physics using 7E learning cycle instructional strategy. Therefore, the hypothesis is not rejected, which indicates that there is no significant difference in the posttest mean achievement scores of male and female students taught Physics using 7E learning cycle instructional strategy, $t(88) = 1.535$, $p>0.05$.

Research Question 4: What is the effect of interaction between method and sex on Physics students' achievement?

Table 7: Descriptive Statistics of Mean and Standard Deviation showing the Effect of Interaction of Method and Sex on Physics Students' Achievement

Groups	**Sex**	**N**	$\underline{X}$	**SD**
PPIS	Male	76	36.09	4.54
	Female	60	36.10	4.42
7E	Male	43	35.05	4.67
	Female	47	33.45	5.17
LM	Male	40	21.95	7.06
	Female	52	24.13	4.76

The result from table 7 showed that the male Physics students taught with PPSIS had a mean achievement score of 36.09 with a standard deviation of 4.54 while the female Physics students taught with PPSIS had a mean score of 36.10 with a standard deviation of 4.41. The male Physics students taught with 7ELCIS had a mean achievement score of 35.05 with a standard deviation of 4.67 while the female Physics students taught with 7ELCIS had a mean score of 33.45 with a standard deviation of 5.17. The male Physics students taught with lecture method had a mean achievement score of 21.95 with a standard deviation of 7.06 while the female students taught with lecture method had a mean achievement score of 24.13 with a standard deviation of 4.76. From the mean scores, it can be seen that female Physics students taught with PPSIS had a slightly higher mean score than their male counterpart. The male students taught with 7ELCIS had a higher mean score than their female counterparts, while female Physics students taught with lecture method had a higher mean score. This shows that there is an interaction effect. To determine if the interaction effect is significant, ANCOVA statistics was used to test 4. This result is shown in Table 8.

Hypothesis 4: There is no significant effect of interaction between method and sex on Physics students' achievement.

Table 8: ANCOVA Statistics of Interaction Effect of Method and Sex on Physics Students' Achievement

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	10258.808[a]	6	1709.801	68.980	.000
Intercept	9481.978	1	9481.978	382.542	.000
Pretest	232.559	1	232.559	9.382	.002
Method	9924.967	2	4962.483	200.207	.000
Sex	3.347	1	3.347	.135	.714
Method * Sex	152.400	2	76.200	3.074	.048
Error	7708.679	311	24.787		
Total	340089.000	318			
Corrected Total	17967.487	317			
a. R Squared = .571 (Adjusted R Squared = .563)					

Table 8 shows the result of Analysis of Covariance (ANCOVA) conducted to show the interaction effect of method and sex on Physics students' achievement. The table shows that the calculated F-value for teaching methods and sex was 3.074 and its p-value was .048. Since the p-value of .048 is greater than 0.05 level of significance, $F(2,317) = 3.074$; $p > 0.05$, the null hypothesis which states that there is no significant interaction effect of method and sex on Physics students' achievement is not rejected.

DISCUSSION

Results from research questions 1 and hypothesis 1 show that there is a significant difference in the mean posttest achievement scores of Physics students taught with PPSIS, 7ELCIS and LM. This analysis showed that the PPSIS yielded a significant higher achievement scores in Physics than the 7ELCIS followed by the LM. This may be predicated on the fact that, teaching with PPSIS is more effective because it offered students opportunity to carry out varieties of hands-on activities in the course of learning. This also indicates that students taught with PPSIS may have een more active in the teaching-learning process seeking for facts and information on their own with little or no assistance from their teacher. This is hinged on the fact that learners learn better when they are actively involved in the teaching-learning process, unlike the LM where students are passive in the learning process. The finding of superiority of PPSIS and 7ELCIS over the LM is in consonance with findings of other studies in literature such as Efeiom and Abdullahi (2021) and Ademola and Nadaraj (2018) who reported that PPSIS was significantly better than the LM in achievement of science subjects and the development of scientific thinking; Cherono, Samikwo and Kabesa (2021) and Shuaibu, Ishak, and Musa (2021) who reported statistically significant difference between the mean scores of those taught using 7ELCIS and those taught using the LM in favour of 7ELCIS .

Results from research questions 2 and 3 and hypotheses 2 and 3 show that there was no significant difference in the mean achievement scores of male and female Physics students taught using PPSIS and 7ELCIS. This is an indication that the male and female taught using PPSIS and 7ELCIS benefited equally from the teaching-learning process. The explanation for this finding is predicated of the level of involvement of both sexes. Both male and female students in the PPSIS and 7ELCIS group were actively involved during the teaching and learning processes. This finding for the PPSIS group is in consonance with those of John (2021), Inah and Anditung (2021) and Olaniyan, Omosewo, and Nwankwo (2015) who reported that sex does not have any influence of students' academic achievement in Physics. Also, the finding for the 7ELCIS group corroborate those of Okafor and Nwonu (2021) and Umar, Soladoye and Benjamin (2022) who reported to no significant difference in the academic achievement scores of male and female students in science subjects.

Results from research questions 4 and hypothesis 4 showed that there was no significant interaction effect of method and sex on Physics students' achievement. In other words, students' achievement in Physics when taught using PPSIS, 7ELCIS and LM are not dependent on students' sex. This indicates that the combined effects of method and sex did not influence Physics students' achievement scores. Rather the variables (methods and sex) acted independently in affecting Physics students' achievement scores. This finding is in line with the findings of Ajaja (2013), Adeyemi (2012), Ezedinma and Nwosu (2018) and Okotcha (2018) who in their different studies found no significant interaction effect between teaching method and sex on students' achievement.

CONCLUSION

The study concluded that Polya's problem-solving instructional strategy and 7E learning cycle instructional strategy are more effective in enhancing Physics students' achievement than the lecture method. Furthermore, the Polya's problem-solving instructional strategy, and 7E learning cycle instructional strategy are not sex-biased regarding enhancing Physics students' achievement. Furthermore, the study concluded that Polya's problem-solving instructional strategy, 7E learning cycle instructional strategy and lecture method did not interact with sex to influence Physics students' achievement.

RECOMMENDATIONS

Arising from the findings, it is recommended that Physics teachers should adopt the use of Polya's problem-solving instructional strategy in teaching Physics in senior secondary schools. Alternatively, Physics teachers should adopt the use of 7E learning cycle instructional strategy as alternative strategy when the use of Polya's problem-solving instructional strategy is not possible in teaching Physics in senior secondary schools. This is because using the Polya's problem-solving or 7E learning cycle instructional strategy, students' prior knowledge was not only elicited at each lesson but they were made to actively participate in the teaching and learning process hence their scoring of higher marks compared to their counterparts in the lecture method group. Physics Curriculum Developers, Educators and Teachers should incorporate Polya's problem-solving and 7E learning cycle instructional strategies in the curriculum, in training and teaching of Physics at the Senior Secondary School Levels. An extensive and result-oriented training programs, seminars and workshops on Polya's problem-solving and 7E learning cycle instructional strategies in teaching Physics concepts should be organized by the government and professional bodies.

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