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Effect of 5E guided inquiry, team teaching, and lecture method on physics students academic achievement in secondary schools in Delta State

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Abstract

The present study investigated the effect of 5E-guided inquiry, team teaching, and lecture methods on the academic achievement of physics students in Delta State secondary schools. The purpose of this research was to investigate the effect of 5E-guided inquiry, team teaching, and lecture methods on physics students' academic achievement. The study used the quasi-experimental non-randomized pre-test, post-test, and planned variation group design. A total of three hundred and twenty-six (326) physics students from nine secondary schools were recruited and sampled in the present study. The study population was thirty-one thousand seven hundred and eleven (31, 711) students consisting of mixed (boys and girls) public school Physics students in Delta State. The Physics Achievement Test (PAT) was administered and used for data collection. Collected data were analyzed using a Paired sample t-test and (ANCOVA). The result showed that there was a significant effect of 5E-guided inquiry, team teaching, and lecture methods on physics students' academic achievement. There is a significant effect of interaction between sex and method on the academic achievement of physics students. Students taught with team teaching method achieved significantly better than students taught with 5E guided inquiry and lecture method. The practical implication infers that teachers should expose physics students to the team-teaching method to promote effective and active learning among students.

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Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
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1. Introduction

The importance of education cannot be over-emphasized as a vital sector because it offers every citizen the foundation and skills required for everyday living. Jacob and Samuel (2020) accentuated that one of the purposes and core objectives of the national policy on secondary education is; to provide the needed educational background for more academic studies, and to develop the student's capacities. The standard of scientific and technological knowledge of any nation is the hallmark on which its development is established. Physics is one of the core sciences which is relevant to advancement in technology. The 5E Instructional Model according to Turan and Matteson (2021) can be used to design a science lesson. The cycle involves cognitive steps of learning that embrace engaging, exploring, explaining, elaborating, and evaluating. The engage stage of the model is proposed to prompt questions about previous knowledge from students and, of course, to inspire them to learn. During the explore stage students conduct laboratory activity or experiment by gathering data, making observations, etc., and these explorations are

officially named in the explained stage. In the elaborate stage, students are permitted to expand their learning to other topics or to satisfy earlier-held questions. Self-explanatory, the evaluation stage offers the teachers and students the chance to both officially and casually ruminate upon what was learned. The claim of Turan and Matteson (2021), through this approach, specifies that students redefine, reorganize, elaborate, and adjust their initial concepts through self-reflection and interaction with their peers and their environment. The 5E instructional model purposefully surges student engagement and participation in the learning process (Lam, Ho, & Chiu, 2022) which is based on cognitive psychology, constructivist learning theory, and best practices. Tiinamaija and Antti (2023) reported that team teaching includes several instructors (four or five) who share the same subject area and are enthusiastically engaging in all aspects of subject development from sequencing of topics in a unit plan or scheme of work and lesson plan, generation of learning activities and development of suitable evaluation instrument. Mononen, Havu-Nuutinen, and Haring (2023) explicitly define team teaching as an assembly of instructors at work definitively, recurrently, and compassionately to help a group of students of any age learn. The lecture method, conventionally referred to as the didactic method is defined as a technique in which one person, normally the teacher, presents a spoken address on a particular subject (Macaranas, 2022). The lecture is used for instructive; simplifying, clarifying, and discussing new materials with learners.

Academic achievement is regularly evaluated via examination or continuous assessments. Snětinová and Koupilová (2013) reported that certain characteristics such as the attitude of students towards Physics, the opinions and beliefs about the subjects, the habits of studying, and constant postponing tendencies are very influential in students' academic achievement. Regardless of how well-resourced the school is or how wide the curriculum is, teaching methods also have a substantial impact on students' academic achievement as well as how easy it is for a delusion to be dismissed. When the finest teaching strategies are employed, physics teachers can have a significant positive impact on students' knowledge hence good academic achievement (Buabeng, Ossei-Anto, & Ampiah, 2014).

2. Research Questions

1. What is the effect of 5E-guided inquiry, team teaching, and lecture methods on physics students' academic achievement?
2. What is the effect of interaction between sex and methods on the academic achievement of physics students?

3. Hypotheses

H_{o} There is no significant effect of 5E-guided inquiry, team teaching, and lecture method on physics students' academic achievement.

H_{o} There is no significant effect of interaction between sex and method on the academic achievement of physics students.

4. Methodology

4.1. Research Design

The study used the quasi-experimental non-randomized pre-test, post-test, and planned variation group design. It is a 3x2 factorial in nature. The design consists of three instructional methods (5E Guided inquiry, Team teaching, and Lecture method), sex (male and female), and repeated testing (pre-test, post-test planned variation). There was no randomization of subjects in this design, intact classes were randomly assigned to the groups. This was done to make up for the three groups (two schools each for 5E guided inquiry, team teaching method, and lecture method). Protest was administered before the commencement of the treatment to the groups. The same PAT was re-administered after six weeks of treatment, with the questions rearranged.

4.2. Population of the Study

The population of the study consisted of all mixed public secondary school (SS2) Physics students in the three senatorial districts in Delta State with a population of 476 secondary schools and 31,711 SS2 students.

4.3. Sample and Sampling Technique

The sample of the study consisted of nine (9) secondary schools drawn from the targeted population. All the schools were mixed. Three hundred and twenty-six (326) senior secondary SS2 students and (9) research assistants from the nine (9) selected public Schools. The study employs stratified random Sampling technique and simple random sampling technique (balloting) using the withdrawal with replacement strategy.

4.4. Instrument

4.4.1. Achievement Test

One major instrument and six weeks lesson plan were used for the three methods of teaching as material. The instrument for data collection is the Physics Achievement Test (PAT). This instrument is made up of two sessions,

section A elicits information on student's biodata, section B is made up of 50 items with multiple choice questions drawn from West Africa Examination Council (WAEC) past questions (2016-2021). Each item in section B consist of one correct and three distracters.

4.4.2. Method of Data Analysis

Paired sample t- test and ANCOVA were used to analyze data. Paired sample t-test statistics was used to compare the effects of 5E guided inquiry, team teaching and lecture method in students' academic achievement while ANCOVA was used to test the Significant effect of the interaction between sex and method (5E guided inquiry, team teaching and lecture method) on the academic achievement of physics students.

4.5. Reliability and Validity

The 50 physics achievement test were subjected to both face and content validity. The PAT was given to three experts, one lecturer in Science Education, one secondary school physics teacher with experience and one lecturer in measurement and evaluation. They commented on the suitability of the questions in terms of language level and cognitive domain assessment and they concluded that the PAT is valid. The reliability of the PAT, was pilot tested using three schools, one from each Senatorial District in Delta State. The subject used in the pilot study comprised a total of 36 students in SS2. This feasibility study is a small experiment designed to test logistics and gather information prior to a larger study in order to make some adjustments where necessary and to improve the latter's quality and efficiency. The test reliability coefficient was calculated using Kuder – Richardson formula 21 (KR-21). When the KR-21 formula was used, the calculation yielded a reliability coefficient (r) of 0.858.

4.6. Ethical Issues

The researcher applied for permission through the principals of the schools to the class teachers to enable her access to the class intended to be used for pilot study.

5. Results and Discussion

This section shows the difference in the pre and posttest score of the three teaching methods.

Table 1 shows the result of paired sample t-test analysis carried out on the effects of 5E guided inquiry, team teaching and lecture method on physics students' achievement. The result shows that the calculated sig-value 0.000 for all is less than 0.05 level of significance (P<0.05). Therefore, the null hypothesis 1 which states that there is no significant effect of 5E guided inquiry, team teaching and lecture method on physics students' academic achievement is rejected. This indicates that there is a significant effect of 5E guided inquiry, team teaching and lecture method on physics students' academic achievement.

Table 1. Paired sample t-test statistics comparing the effect of 5E guided inquiry, team teaching and lecture method in students' academic achievement.

Teaching method	N	Pre-test		Post-test		Mean diff.	Degree of freedom (Df)	Tcal	Sig (2tailed)
		Mean	SD	Mean	SD				
5E guided inquiry teaching	90	15.09	5.10	36.86	11.75	21.77	89	24.86	0.000*
Team teaching	128	15.42	5.05	46.77	14.68	31.35	127	35.31	0.000*
Lecture method	108	13.37	4.92	29.19	9.44	15.81	107	30.07	0.000*

Note: Data presented as mean and standard deviation (SD); *= significant difference at p< 0.05.

Table 2. Summary of ANCOVA test of significant effect of the interaction between sex and method (5E guided inquiry, team teaching and lecture method) on the academic achievement of physics students.

Source	Type III sum of squares	Degree of freedom (Df)	Mean square	F	Sig.
Corrected model	56977.520	6	9496.253	286.424	0.000
Intercept	1286.424	1	1286.424	36.801	0.000
Pretest	36798.822	1	36798.822	1109.918	0.000
Teaching method	10442.123	2	5221.061	157.477	0.000
Sex	189.593	1	189.593	5.718	0.017
Teaching method and sex	333.426	2	166.713	5.028	0.007
Error	10576.296	319			
Total	543480.000	326			
Corrected total	67553.816	325			

Note: R squared = 0.843 (Adjusted R squared = 0.840).

Table 2 shows the result of analysis of covariance (ANCOVA) conducted to show the interaction effect of methods and sex on physics students' achievement. The table established that the critical sig value of 0.007 is less than the alpha value of 0.05 ($p<0.05$). This indicates that the interaction effect is significant. Therefore, there is a significant interaction effect of methods and sex on physics students' academic achievement, so hypothesis 2 is accepted.

The graph in Figure 1 shows that the interaction effect is disordinal in nature.

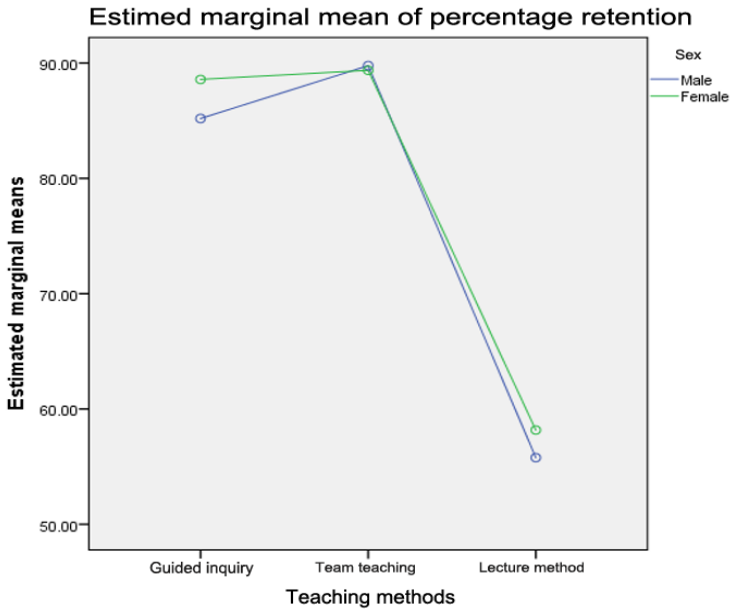

Figure 1. Interaction effect of methods and sex.

6. Conclusion

From the findings of the study, it was concluded that: Students taught with team teaching (TT) method achieved higher than students taught with 5E guided inquiry (GI), and lecture method (LM). The use of 5E guided inquiry (GI), team teaching (TT) and lecture method (LM) positively influenced students' academic achievement in Physics, with team teaching being most effective, followed by 5E guided inquiry and lecture method respectively. The study concluded also that the interaction of instructional methods and sex on student's academic achievement in Physics was significant.

7. Future Consideration

The researcher recommends that further studies should be carried out on the effects of 5E guided inquiry, team teaching and lecture method on physics students' academic achievement in other area to ascertain the method that proves better in teaching physics students.

8. Discussion of Findings

The finding showed that there is a significant effect of 5E guided inquiry, team teaching and lecture method on Physics students' academic achievement. It shows a clear mean difference in the pretest and posttest scores of students taught with 5E guided inquiry, team teaching and lecture method with team teaching being more effective. The post-test scores of Physics students in the 5E guided inquiry group, team teaching and lecture method groups are significantly higher than their pre-test scores. This showed that Physics students in the 5E guided inquiry, team teaching and lecture method groups performed better in the posttest. Students who were taught using 5E guided inquiry and team teaching outperformed those who were taught using lecture method. This finding may be due to the various teachings and activities that students were exposed to as they were pretested. This finding is in agreement with the findings of Opara (2011).

The discoveries of the research similarly disclosed that there is a substantial interaction effect of methods and sex on physics students' academic achievement. This could be hinged on the fact that students have different study habits which could influence their learning not that the method is sex influenced. This finding corroborates the findings of Gadzma (2011); Opara (2011) and Ashiq, Mohammad, and Azra (2011).

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