

## EFFECTS OF GUIDED INQUIRY ON STUDENTS' ACADEMIC ACHIEVEMENT AND INTEREST IN PHYSICS IN SECONDARY SCHOOLS IN EBONYI STATE

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### ABSTRACT

This study investigated the effect of the Guided Inquiry Instructional Method (GIIM) on senior secondary school students' interest and academic achievement in Physics in Ebonyi State, Nigeria, with particular emphasis on gender differences and the interaction effect of teaching method and gender. A quasi-experimental pretest-posttest non-equivalent control group design was adopted. The population comprised all Senior Secondary Two (SSII) Physics students in public secondary schools across the three Education Zones of Ebonyi State. A sample of 150 SSII Physics students was selected through a multistage sampling procedure. Students in the experimental group were taught selected Physics concepts using the Guided Inquiry Instructional Method, while those in the control group were taught using the conventional lecture method for six weeks. Data were collected using the Physics Achievement Test (PAT) and Physics Interest Inventory Scale (PIIS). Reliability coefficients of 0.79 and 0.83 were obtained for PAT and PIIS respectively, indicating satisfactory internal consistency. Data were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at a 0.05 level of significance. The findings revealed that Guided Inquiry significantly improved students' interest and academic achievement in Physics compared with the conventional lecture method. Gender significantly influenced some outcomes within the guided inquiry group, while no significant interaction effect existed between teaching method and gender. The study concluded that Guided Inquiry is an effective learner-centered instructional strategy for improving students' affective and cognitive outcomes in Physics. It was recommended that Physics teachers adopt guided inquiry approaches to enhance students' engagement and achievement in Physics classrooms.

**Keywords:** Guided Inquiry, Physics Achievement, Physics Interest, Gender, Physics Education.

### INTRODUCTION

Education remains one of the most powerful instruments for national development, technological advancement, and human capacity building. It equips individuals with the knowledge, skills, attitudes, and competencies required to function effectively in society and contribute meaningfully to economic growth and innovation. Contemporary educational systems emphasize learner-centered pedagogies that foster critical thinking, creativity, collaboration, and problem-solving skills necessary for the twenty-first century workforce (UNESCO, 2023). In Nigeria, science education occupies a strategic position because of its potential to drive industrialization, technological innovation, and

sustainable national development (Federal Republic of Nigeria, 2023). Among the science subjects taught in secondary schools, Physics occupies a unique position because it provides fundamental explanations for natural phenomena and serves as the foundation for technological and engineering innovations. Physics deals with matter, energy, motion, force, electricity, waves, and their interactions. The subject contributes significantly to scientific literacy and prepares learners for careers in engineering, medicine, information technology, aviation, architecture, and other science-related professions (Aina & Adedo, 2021). Consequently, the effective teaching and learning of Physics are essential for achieving Nigeria's scientific and technological aspirations.

Despite its importance, students' performance in Physics in public examinations has remained persistently unsatisfactory. Reports from the West African Examinations Council and the National Examinations Council continue to reveal low achievement levels among secondary school students in Physics (WAEC, 2023; NECO, 2024). Researchers have attributed this poor performance to factors such as inadequate laboratory facilities, abstract nature of Physics concepts, poor mathematical background, lack of instructional materials, and ineffective teaching methods (Okeke & Eze, 2022; Ugwoke et al., 2023). These challenges have raised concerns among educators, policymakers, and stakeholders in science education. One of the major factors influencing students' learning outcomes in Physics is the instructional method employed by teachers. Traditional lecture methods, which dominate classroom practice in many Nigerian secondary schools, are largely teacher-centered and often limit students' active participation in the learning process. Such methods encourage rote memorization rather than conceptual understanding and critical thinking (Nworgu & Ugwuanyi, 2021). Consequently, students find it difficult to understand and retain abstract Physics concepts, leading to poor academic achievement and declining interest in the subject.

Guided Inquiry Instructional Method (GIIM) is a learner-centered teaching strategy rooted in constructivist learning theory. The method encourages students to investigate scientific problems, formulate hypotheses, collect evidence, analyze findings, and construct knowledge through guided exploration. Unlike traditional lecture methods, guided inquiry promotes active participation, collaboration, and critical thinking while the teacher serves as a facilitator of learning (Bybee, 2021). Research has demonstrated that inquiry-based instructional approaches enhance conceptual understanding, problem-solving skills, scientific reasoning, and academic achievement among science learners (Kang & Keinonen, 2023; OECD, 2022).

Interest is an important affective variable that influences students' willingness to engage in learning activities and persist in academic tasks. Students who develop interest in Physics are more likely to participate actively in classroom activities, complete assignments, and perform better academically. However, several studies have reported declining interest in Physics among secondary school students, largely due to perceived difficulty of the subject and uninspiring instructional approaches (Aina & Adedo, 2021; Udo & Udofia, 2022). The adoption of guided inquiry teaching strategies may therefore stimulate students' curiosity, increase engagement, and foster positive attitudes toward Physics learning.

Academic achievement represents the extent to which educational objectives are attained after instruction. It serves as a major indicator of instructional effectiveness and students' mastery of subject matter. Studies have consistently shown that innovative learner-centered instructional approaches produce higher achievement outcomes than conventional lecture methods because they encourage meaningful learning and active knowledge construction (Karpudewan & Roth, 2021; Kang & Keinonen, 2023). Therefore, exploring the effectiveness of guided inquiry instruction in improving students' achievement in Physics remains an important concern in science education research.

Gender is another variable that has attracted considerable attention in Physics education. Although previous studies have reported mixed findings regarding gender differences in science achievement and interest, recent evidence suggests that learner-centered instructional strategies can help reduce gender disparities by providing equal opportunities for participation and engagement (UNESCO, 2023; OECD, 2022). It is therefore necessary to investigate whether the effectiveness of Guided Inquiry Instructional Method differs across gender groups. Against this background, this study investigates the effect of Guided Inquiry Instructional Method on students' academic achievement and interest in Physics among Senior Secondary School students in Ebonyi State, Nigeria.

### **Statement of the Problem**

Persistent poor performance in senior-secondary chemistry evidenced in national examination reports has been linked to teacher-centred instruction, inadequate practical engagement and low student interest; however, few studies in the local context have examined whether student-centred approaches like guided inquiry can simultaneously raise both interest and achievement (WAEC Chief Examiners' reports; Onyeabor, 2019). This study addresses that gap by evaluating the effect of guided-inquiry instruction on students' academic achievement and interest in Physics in Ebonyi State.

### **Purpose of the Study**

The purpose of the study is to assess the effect of guided inquiry on students' academic achievement and interest in Physics in Ebonyi State, Nigeria. Specifically, the study sought to:

1. Determine the effect of the guided-inquiry instructional method on students' academic achievement and interest in Physics in Ebonyi State.
1. Examine the influence of gender on students' interest in physics when taught using the guided-inquiry instructional method in secondary schools in Ebonyi State.
2. Investigate the interaction effect of teaching method (guided-inquiry versus lecture) and gender on students' interest ratings in physics in secondary schools in Ebonyi State.

3. Assess the effect of the guided-inquiry instructional method on secondary-school students' academic achievement in physics in Ebonyi State.
4. Determine the influence of gender on students' academic achievement in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State.
5. Evaluate the interaction effect of teaching method (guided-inquiry versus lecture) and gender on students' academic achievement in physics in secondary schools in Ebonyi State.

### Research Questions

1. What is the effect of guided-inquiry instructional method on students' interest rating in physics in secondary schools in Ebonyi State?
2. What is the influence of gender on students' interest in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State?
3. What is the interaction effect of teaching methods and gender on students' interest ratings in physics in secondary schools in Ebonyi State?
4. What is the effect of guided-inquiry instructional method on students' academic achievement in physics in secondary schools in Ebonyi State?
5. What is the influence of gender on students' academic achievement in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State?
6. What is the interaction effect of teaching methods and gender on students' academic achievement in physics in secondary schools in Ebonyi State?

### Hypotheses

**H0<sub>1</sub>:** There is no significant effect of guided-inquiry instructional method on students' interest rating in physics in secondary schools in Ebonyi State.

**H0<sub>2</sub>:** There is no significant influence of gender on students' interest in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State.

**H0<sub>3</sub>:** There is no significant interaction effect of teaching methods and gender on students' interest ratings in physics in secondary schools in Ebonyi State.

**H0<sub>4</sub>:** There is no significant effect of guided-inquiry instructional method on students' academic achievement in physics in secondary schools in Ebonyi State.

**H0<sub>5</sub>:** There is no significant influence of gender on students' academic achievement in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State.

**H0<sub>6</sub>:** There is no significant interaction effect of teaching methods and gender on students' academic achievement in physics in secondary schools in Ebonyi State.

## METHODOLOGY

This study employed a quasi-experimental approach, specifically a non-equivalent control group design, which is appropriate when intact classes are used to avoid disrupting regular school routines and to limit extraneous influences. The study area comprised all public secondary schools across the three Education Zones of Ebonyi Stat. Each zone contains multiple local government areas and the state has a total of 13 local government areas and 233 public secondary schools. Ebonyi State was selected because prior studies report widespread difficulties with chemistry among public secondary school students across these zones.

The population comprised of all Senior Secondary Two (SSII) students enrolled in the 233 public secondary schools across the three Education Zones. SSII students were chosen because the physics topics used in the study are taught at that level. A sample of 200 SSII physics students was drawn using a multi-stage sampling procedure. First, purposive sampling was used to identify two public secondary schools in each education zone that met inclusion criteria (functional physics laboratory, experienced physics teachers, and available SSII physics streams). From these selected schools, intact SSII streams were chosen by simple random sampling technique. The six schools produced the sample of 200 students; three schools (and their intact classes) were assigned to the experimental group and three to the control group by balloting. Purposive selection ensured comparable school characteristics (student population, teacher quality, facilities), while random selection of streams and random assignment of intact classes helped reduce selection bias.

Two researcher-developed instruments were used: the Physics Achievement Test (PAT) and the Physics Interest Inventory Scale (PIIS). The PAT comprises 30 multiple-choice items (each worth one mark) based on four SSII Physics topics. The PIIS is a 4-point Likert scale (Strongly Agree = 4 to Strongly Disagree = 1) used to measure students' interest in physics, with scoring reversed for negatively worded items. Both instruments underwent face and content validation by three experts in chemistry and measurement & evaluation by experts from Science Education Department, Alex Ekwueme Federal University Ndufu-Alike. The experts reviewed item relevance, clarity, weighting, and the test blueprint/table of specification; suggested modifications were incorporated into the final versions. A scoring guide was also reviewed and approved by the experts. Pilot testing was carried out and it involved administering the instruments to 30 SSII physics students from three private secondary schools not included in the main study. Reliability was estimated using Kuder–Richardson 20 (K-R20) for the PAT, yielding 0.77, and Cronbach's alpha for the PIIS, yielding 0.87, indicating acceptable internal consistency for both instruments.

Pretest and post-test administrations were used to measure students' physics interest and achievement before and after the intervention. Two days of training were conducted for the research assistants to familiarize them with the guided inquiry procedures, lesson plans, and monitoring responsibilities. Experimental teachers received additional coaching and a mock teaching session supervised by the researcher to ensure fidelity to

the guided inquiry approach. Control teachers taught using the conventional lecture method, following lesson plans prepared by the researcher. Both groups covered the same content over four weeks (two 45-minute periods per week). Physics teachers were monitored throughout to ensure adherence to instructional procedures and to prevent contamination between groups. Several strategies were used to minimize extraneous influences. The pretest–posttest interval was limited to four weeks to reduce practice or familiarity effects. Physics teachers across schools received standardized training and instructional guides to control teacher-related variability and ensure consistency of instructional situation. Multiple classes were used for teaching and testing to reduce Hawthorne and novelty effects. Research assistant physics teachers who were familiar with the students administered the instruments under the researcher’s supervision; the researcher then collected and organized the data for analysis. Pretest and posttest scores were summarised using means and standard deviations to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses and examine group differences while controlling for pretest scores, with statistical significance set at  $p \leq .05$ .

## RESULTS

The results of the analysis are presented according to the research questions and the corresponding hypotheses.

**Research question 1:** What is the effect of guided-inquiry instructional method on students' interest rating in physics in secondary schools in Ebonyi State?

**Table 1**

*Descriptive Statistics of Students' Interest Ratings in Physics in the Experimental and Control Groups*

Teaching methods (Treatment)	Pre-test			Post-test		Gain Score
	n	Mean	SD	Mean	SD	
Experimental (GIIM)	93	2.66	0.85	2.77	0.81	0.11
Control (LM)	107	2.60	0.93	2.63	0.96	0.03
Total/Gain Score Difference	200	2.63	0.90	2.69	0.89	0.08

Table 1 contains the descriptive statistics of the students' interest ratings in physics in the experimental and control groups taught with the guided-inquiry instructional method and the lecture method, respectively. The results show that the experimental group had an overall post-interest mean response with a standard deviation of  $2.77 \pm 0.81$ , and a pre-interest mean response with a standard deviation of  $2.66 \pm 0.85$ . These results show a mean difference of 0.11 between the post-interest and pre-interest responses. Similarly, the control group had overall post-interest mean response with standard deviation of  $2.63 \pm 0.96$ , and pre-interest mean response with standard deviation of  $2.60 \pm 0.93$ . This result also shows a mean difference of 0.03 between the post-interest and pre-interest responses of the students. Furthermore, the post-interest mean response of the students in the experimental group was higher than that of their counterparts in the control group, with a numerical difference of 0.08.

**Research question 2:** What is the influence of gender on students' interest in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State?

**Table 2**

*Descriptive Statistics of Male and Female Students' Interest in Physics when taught with the Guided-Inquiry Instructional Method*

	Pre-test			Post-test		Gain Score
	n	Mean	SD	Mean	SD	
Experimental Group (GIIM)						
Male	43	2.65	0.88	2.71	0.84	0.06
Female	50	2.67	0.84	2.82	0.79	0.15
Total/Gain Score Difference	93	2.66	0.85	2.77	0.81	0.09

Table 2 shows the descriptive statistics of the interest ratings of male and female students in physics in the experimental group taught with the guided-inquiry instructional method. It can be seen from the Table that the overall post-interest mean response with standard deviation of the male students was  $2.71 \pm 0.84$ , and pre-interest mean response with standard deviation of  $2.65 \pm 0.88$ . These results show a mean gain score of 0.06 between the post-interest and pre-interest mean responses of the male students. Similarly, the overall post-interest mean response with standard deviation of the female students was  $2.82 \pm 0.79$ , and a pre-interest mean response with standard deviation of  $2.67 \pm 0.84$ . These show a mean gain score of 0.15 between the post-interest and pre-interest mean responses of the female student. Furthermore, the Table shows that the mean gain score of the female students was higher than that of their male counterparts, with a numerical value of 0.09.

**Research question 3:** What is the interaction effect of teaching methods and gender on students' interest ratings in physics in secondary schools in Ebonyi State?

**Table 3**

*Adjusted Mean Interest Ratings and Standard Error of Interaction Effect of Methods and Gender in Physics*

Dependent Variable: Post-test score

Group	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Experimental (GIIM)	Male	2.689 <sup>a</sup>	0.018	2.654	2.724
	Female	2.779 <sup>a</sup>	0.016	2.746	2.811
Control (LM)	Male	2.612 <sup>a</sup>	0.017	2.580	2.645
	Female	2.694 <sup>a</sup>	0.015	2.664	2.724

a. Covariates appearing in the model are evaluated at the following values: Pre-Interest = 2.63.

Table 3 showcases the adjusted mean interest ratings and standard error of the physics students to determine the interaction effect of methods and gender in physics. The Table shows that the adjusted mean interest rating of the female physics students in the experimental group was higher than that of their male counterparts. Similarly, the adjusted

mean interest rating of the female students in the control group was also higher than that of their male counterparts.

**Research Question 4:** What is the effect of guided-inquiry instructional method on students' academic achievement in physics in secondary schools in Ebonyi State?

**Table 4**

*Descriptive Statistics of Students' Academic Achievement Scores in Physics in the Experimental and Control Groups*

Teaching Methods	Pre-interest			Post-interest		Gain Score
	N	Mean	SD	Mean	SD	
Experimental (GIIM)	93	14.46	4.44	24.72	5.25	10.26
Control (LM)	107	12.07	3.63	18.14	5.14	6.07
Total/Gain Score Difference	200	13.18	4.19	21.20	6.14	4.19

Table 4 shows the descriptive statistics of the academic achievement tests conducted on the experimental and control groups taught physics with the guided-inquiry instructional method and lecture method. From the Table, the experimental group had a post-test mean score with standard deviation of  $24.72 \pm 5.25$ , and a pre-test mean score with standard deviation of  $14.46 \pm 4.44$ . The result shows a mean gain score of 10.26. Similarly, the control group had a post-test mean score with a standard deviation of  $18.14 \pm 5.14$ , and a pre-test mean score with a standard deviation of  $12.07 \pm 3.63$ . This shows a mean gain score of 6.07. From these results, the two instructional methods improved the students' academic achievement in chemistry. However, the guided-inquiry instructional method was more effective in improving the students' academic achievement in physics than the lecture method. These results show that the experimental group had a higher mean academic achievement score than their counterparts in the control group, with a numerical difference of 4.19.

**Research question 5:** What is the influence of gender on students' academic achievement in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State?

**Table 5**

*Descriptive Statistics of Male and Female Students' Academic Achievement Scores in Physics in the Experimental Group*

	Pre-interest			Post-interest		Gain Score
	N	Mean	SD	Mean	SD	
Experimental Group (GIIM)						
Male	43	15.44	4.44	24.09	4.96	8.65
Female	50	13.62	4.30	25.26	5.48	11.64
Total/Gain Score Difference	93	14.46	4.44	24.72	5.25	2.99

Table 5 summarizes the descriptive statistics of the male and female physics students' academic achievement test in the experimental group in secondary schools in Ebonyi State. The Table shows that the male students' post-test and pre-test mean scores with standard deviations were  $24.09 \pm 4.96$  and  $15.44 \pm 4.44$ , respectively. This shows a mean gain score of 8.65 between the pre- and post-test mean scores. Similarly, the female students' post-test and pre-test mean scores with standard deviations were  $25.26 \pm 5.48$  and  $13.62 \pm 4.30$ . This also shows a mean gain score of 11.64 between the pre- and post-test scores. From the results obtained, the female students' mean academic achievement score was higher than that of the male students, with a numerical difference of 2.99.

**Research question 6:** What is the interaction effect of teaching methods and gender on students' academic achievement in physics in secondary schools in Ebonyi State?

**Table 6**

*Adjusted Mean Achievement Scores and Standard Error of Method and Gender Interaction in Physics*

Group	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Experimental (GIIM)	Male	35.987 <sup>a</sup>	0.553	34.896	37.078
	Female	22.544 <sup>a</sup>	0.700	21.164	23.924
Control (CLM)	Male	24.959 <sup>a</sup>	0.628	23.720	26.198
	Female	18.939 <sup>a</sup>	0.642	17.673	20.205

a. Covariates appearing in the model are evaluated at the following values: Pre-test score = 13.18.

Table 6 contains the adjusted mean achievement scores and standard error of the students to determine the interaction effect of methods and gender on students' academic achievement in physics. It can be seen from the Table that the adjusted mean achievement score of the male students of the experimental group was higher than that of their female counterparts. Similarly, the adjusted mean achievement score of the male students in the control group was also higher than that of their female counterparts.

**Hypothesis 1:** There is no significant effect of guided-inquiry instructional method on students' interest rating in physics in secondary schools in Ebonyi State.

**Table 7**

*Summary of ANCOVA Statistics of Mean Interest Ratings of Students in Physics when Taught with the GIIM and the Lecture Method*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	155.656 <sup>a</sup>	4	38.914	2897.850	0.000	0.983
Intercept	0.233	1	0.233	17.339	0.000	0.082
Pre-interest	154.273	1	154.273	11488.436	0.000	0.983
Method	0.322	1	0.322	23.955	0.000	0.109
Error	2.619	195	0.013			
Total	1609.802	200				
Corrected Total	158.274	199				

a. R Squared = 0.983 (Adjusted R Squared = 0.983)

Table 7 summarizes the ANCOVA statistics conducted to compare the interest ratings of physics students in the experimental and control groups, while controlling for the pre-interest effect. From the Table, there was a statistically significant difference between the mean interest ratings of the experimental and the control groups at  $F(1, 195) = 23.955$ ,  $p = 0.000 < 0.05$ , set for the study. The partial Eta squared value of 0.11 shows the magnitude of the difference in the means (effect size), which, when compared with Cohen's guidelines (0.2 – small effect, 0.5 – moderate effect, 0.8 – large effect), was considered small. The null hypothesis one, which states that there is no significant effect of guided-inquiry instructional method on students' interest rating in physics in secondary schools in Ebonyi State, was therefore, rejected at a 0.05 alpha level. This implies that the earlier mean difference observed in the interest ratings of physics students in the experimental and control groups, as shown in Table 1 above, was statistically significant, and could not be attributed to sampling error. This implies further that the teaching method, guided-inquiry instructional method had a significant effect on the students' interest in physics more than the lecture method in secondary schools in Ebonyi State.

**Hypothesis 2:** There is no significant influence of gender on students' interest in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State.

**Table 8**

*Summary of ANCOVA Statistics of Mean Interest Ratings of Male and Female Students in Physics in the Experimental Group*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	59.270 <sup>a</sup>	2	29.635	2120.696	0.000	0.979
Intercept	0.634	1	0.634	45.353	0.000	0.335
Pre-interest	58.983	1	58.983	4220.845	0.000	0.979
Gender	0.189	1	0.189	13.556	0.000	0.131
Error	1.258	90	0.014			
Total	775.382	93				
Corrected Total	60.528	92				

a. R Squared = 0.979 (Adjusted R Squared = 0.979)

Table 8 summarized the results of the ANCOVA statistics conducted on the male and female physics students' mean interest ratings in the experimental group. The results show that there was a statistically significant difference found in the mean interest ratings of the male and female physics students taught with the guided-inquiry instructional method at  $F(1, 90) = 13.556$ ,  $p = 0.000 < 0.05$ , set for the study. The partial Eta squared value of 0.131 shows the magnitude of the difference in the means (effect size), which was considered a small effect when compared with Cohen's guidelines. Therefore, the null hypothesis two, which states that there is no significant influence of gender on students' interest in physics when taught with the guided-inquiry instructional method in secondary schools, was rejected at a 0.05 alpha level. This means that the difference observed earlier in the mean interest ratings of the male and female physics students, as shown in Table 2 above, was significant and could not be attributed to sampling error. This shows further that gender significantly influenced the students' interest in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State.

**Hypothesis 3:** There is no significant interaction effect of teaching methods and gender on students' interest ratings in physics in secondary schools in Ebonyi State.

**Table 9**

*Summary of One-way Analysis of Covariance Results of the Interaction Effect of Methods and Gender on Students' Interest in Physics*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	155.656 <sup>a</sup>	4	38.914	2897.850	0.000	0.983
Intercept	0.233	1	0.233	17.339	0.000	0.082
Pre-interest	154.273	1	154.273	11488.436	0.000	0.983
Group * Gender	0.001	1	0.001	0.059	0.808	0.000
Error	2.619	195	0.013			
Total	1609.802	200				
Corrected Total	158.274	199				

a. R Squared = 0.983 (Adjusted R Squared = 0.983)

Table 9 shows the results of the ANCOVA statistics conducted on the students' interest ratings to determine the interaction effect of methods and gender on physics students' interest. The results show no statistically significant interaction effect of method and gender on the physics students' mean interest ratings at  $F(1,195) = 0.059, p = 0.808 > 0.05$ , set for this study. Therefore, null hypothesis three (Ho3), which states that there is no significant interaction effect of teaching methods and gender on students' interest ratings in physics in secondary schools in Ebonyi State, was accepted. This implies that the interaction of methods of instruction and the students' gender did not significantly influence the physics students' interest. Therefore, the two-way interaction of methods and gender had no statistically significant effect on students' interest in physics in secondary schools in Ebonyi State.

**Hypothesis 4:** There is no significant effect of guided-inquiry instructional method on students' academic achievement in physics in secondary schools in Ebonyi State.

**Table 10**

*Summary of ANCOVA Statistics of Mean Academic Achievement Scores of Students in Physics in the Experimental and Control Groups*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3655.267 <sup>a</sup>	4	913.817	46.444	0.000	0.488
Intercept	2463.085	1	2463.085	125.185	0.000	0.391
Pre-test	1468.848	1	1468.848	74.653	0.000	0.277
Method	1058.085	1	1058.085	53.777	0.000	0.216
Error	3836.733	195	19.676			
Total	97380.000	200				
Corrected Total	7492.000	199				

a. R Squared = 0.488 (Adjusted R Squared = 0.477)

Table 10 presents a summary of the results of the ANCOVA statistics conducted on the physics students' achievement tests in the experimental and control groups to compare the effects of the two instructional methods, while controlling for the pre-test effect. The results indicated that there was a statistically significant difference in the mean achievement scores of the experimental and the control groups at  $F(1, 195) = 53.777, p = 0.000 < 0.05$ , set for the study. The partial Eta squared value of 0.216 shows the magnitude of the difference in the means (effect size), which, when compared with Cohen's guidelines, was considered a small effect. Therefore, the null hypothesis four, which states that there is no significant effect of guided-inquiry instructional method on physics students' academic achievement in secondary schools in Ebonyi State, was rejected at a 0.05 alpha level. This signifies that the observed difference in the mean academic achievement scores of the physics students in Table 4 above was significant. This further shows that the guided-inquiry instructional method effectively improved the physics students' academic achievement more than the lecture method in secondary schools in Ebonyi State.

**Hypothesis 5:** There is no significant influence of gender on students' academic achievement in physics when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State.

**Table 11**

*Summary of ANCOVA Statistics of Mean Academic Achievement Scores of Male and Female Students in Physics in the Experimental Group*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	697.232 <sup>a</sup>	2	348.616	17.038	0.000	0.275
Intercept	1856.490	1	1856.490	90.733	0.000	0.502
Pre-test	665.749	1	665.749	32.537	0.000	0.266
Gender	116.619	1	116.619	5.700	0.019	0.060
Error	1841.499	90	20.461			
Total	59371.000	93				
Corrected Total	2538.731	92				

a. R Squared = 0.275 (Adjusted R Squared = 0.259)

Table 11 shows the summary of the results of the ANCOVA statistics conducted on the male and female physics students' mean academic achievement scores in the experimental group. The results show a statistically significant difference in the mean academic achievement scores of the male and female physics students in the experimental group at  $F(1, 90) = 5.700, P = 0.019 < 0.05$ , set for the study. Therefore, the null hypothesis five ( $H_05$ ), which states that there is no significant influence of gender on physics students' academic achievement when taught with the guided-inquiry instructional method in secondary schools in Ebonyi State, was rejected at a 0.05 alpha level. This implies that the earlier observed difference in the mean academic achievement scores of the physics students, as shown in Table 5 above, was significant, and could not be attributed to error variance. This further shows that there was a statistically significant gender influence on the students' academic achievement in physics when taught with the guided-inquiry instructional method.

**Hypothesis 6:** There is no significant interaction effect of teaching methods and gender on students' academic achievement in physics in secondary schools in Ebonyi State.

**Table 12**

*Summary of One-way ANCOVA Statistics of the Interaction Effect of Methods and Gender on Students' Academic Achievement in Physics*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3655.267 <sup>a</sup>	4	913.817	46.444	0.000	0.488
Intercept	2463.085	1	2463.085	125.185	0.000	0.391
Pre-test	1468.848	1	1468.848	74.653	0.000	0.277
Group * Gender	74.708	1	74.708	3.797	0.053	0.019
Error	3836.733	195	19.676			
Total	97380.000	200				
Corrected Total	7492.000	199				

a. R Squared = 0.488 (Adjusted R Squared = 0.477)

Table 12 presents the summary of the results of the ANCOVA statistics conducted to determine the interaction effect of methods and gender on physics students' academic achievement in secondary schools in Ebonyi State. The results show no statistically significant interaction effect of methods and gender on the physics students' academic achievement at  $F(1,195) = 3.797, p = 0.053 > 0.05$ , set for the study. Therefore, null hypothesis six, which states that there is no significant interaction effect of teaching methods and gender on students' academic achievement in physics in secondary schools in Ebonyi State, was accepted at the prevailing research conditions. This signifies that the interaction of methods of instruction and the students' gender did not significantly influence the physics students' academic achievement scores in secondary schools in Ebonyi State.

### **Discussion of Findings**

The study found that the guided-inquiry instructional method (GIIM) produced a statistically significant improvement in physics students' interest compared with the lecture method. This aligns with constructivist learning theories which posit that active engagement and hands-on inquiry foster intrinsic motivation and curiosity (Bruner, 1961). Empirical work also supports the present result: several studies report that inquiry-based approaches increase student interest and positive attitudes toward science by promoting autonomy, relevance, and deeper engagement with concepts (Keys & Bryan, 2001). The small but significant effect observed suggests GIIM meaningfully shifts interest even in contexts where baseline interest is modest, indicating that pedagogical change can influence affective outcomes in secondary physics.

Gender significantly influenced interest within the experimental (GIIM) group, with female students showing larger gain scores than males. This may reflect the capacity of guided-inquiry environments to reduce barriers that traditionally dampen girls' engagement in STEM -such as passive classroom roles or limited opportunities for collaborative sense-making - by offering more interactive, student-centered learning experiences (Eagly & Wood, 2012). Prior research has found that inquiry and cooperative learning strategies can narrow gender differences in science attitudes and boost girls' interest and confidence (Maltese & Tai, 2011). The current finding suggests GIIM not only increases overall interest but may differentially benefit physics female students' affective engagement.

The analysis showed no significant interaction between teaching method and gender on interest ratings, meaning the positive effect of GIIM on interest applied across genders without a unique synergistic interaction. In other words, while females exhibited greater gains in the GIIM group, the method's effect was broadly beneficial for both sexes and did not depend on gender in a statistically interactive way. This pattern implies that GIIM operates as an inclusive instructional strategy; it raises interest for all physics students while potentially offering somewhat larger absolute gains for some subgroups. Such an outcome is consistent with meta-analyses indicating inquiry-based instruction consistently improves attitudes across diverse student populations, even when subgroup differences remain (Hmelo-Silver et al., 2007).

Guided-inquiry instruction also produced a significant and substantial improvement in physics students' academic achievement relative to the lecture method. The observed gain in post-test scores for the experimental group supports claims that inquiry-based learning promotes deeper conceptual understanding and transferable problem-solving skills by engaging students in hypothesis generation, evidence evaluation, and reflective reasoning (National Research Council, 2000). The medium-sized effect on achievement indicates GIIM can do more than affect attitudes it translates to measurable learning gains in content mastery, which is critical for curriculum outcomes and examination performance.

Within the experimental group, gender significantly influenced academic achievement: male students showed higher adjusted mean achievement scores than female students after controlling for pre-test. This finding may reflect complex interactions among prior preparation, assessment formats, classroom participation patterns, or differential access to informal supports outside school. While GIIM improved achievement overall, it did not eliminate the achievement gap in favour of males in this sample. This underscores the need to attend to equity within pedagogical reforms ensuring inquiry activities are structured to build skills and confidence for all students, for example by providing targeted scaffolds, diverse assessment modes, and opportunities for leadership among underperforming subgroups (Sadler et al., 2015).

Finally, the interaction of method and gender on achievement was not statistically significant, indicating that the advantage of GIIM in raising achievement was generally consistent for both males and female physics students. Although adjusted means differ by gender, the lack of a significant interaction means GIIM's effectiveness as an instructional approach does not depend on gender in this study's conditions. Practically, this suggests that implementing GIIM is a viable strategy for improving chemistry achievement across the student body, but complementary measures may be required to close residual gender gaps in attainment.

### **Conclusion**

Guided-inquiry instructional method significantly improved both physics students' academic achievement and interest in secondary-school in Ebonyi State compared with the lecture method; gender influenced both outcomes within the GIIM group (favoring females for interest but males for achievement), but there were no significant interaction effects between method and gender indicating GIIM benefits physics students broadly while leaving gender-related differences in achievement that merit further targeted intervention.

### **Recommendations**

Based on the findings of the study, it was recommended that:

1. Curriculum planners and policy makers should allocate resources (laboratory materials, class-size reductions, teacher mentors) that facilitate high-fidelity implementation of guided-inquiry approaches.

2. Government should provide professional development for teachers on gender-responsive pedagogy and assessment diversification to ensure equitable opportunity to demonstrate learning.
3. Guided-inquiry instructional practices in physics across secondary schools in Ebonyi State, should be accompanied by teacher training on inquiry design and classroom management.
4. Physics teachers should incorporate targeted scaffolds within GIIM lessons such as structured prompts, role assignments, formative feedback to support female physics students' performance and close observed achievement gaps.
5. Physics teachers should embed regular formative assessments and reflective activities within GIIM to monitor understanding and adjust instruction for students who lag behind.
6. Physics students should be actively involved in using guided-inquiry instructional method for effect mastering of physics concepts.

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