

Original Research

Effect of Inquiry-Based Teaching Method on Senior Secondary School Students' Achievement in Physics

Fagbenro W. Ayoola , Judges Ernest Yinjoh 
Department of Science Education, Federal University Wukari

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ABSTRACT

This study investigated the effects of inquiry-based learning (IBL) on the physics achievement of senior secondary II students in Wukari Metropolis, Taraba State. The study adopted a pre-test post-test non-equivalent control group design. Data were collected in order to answer four research questions and test four hypotheses. The sample comprised senior secondary II Physics students (male =55 and female =65) drawn from the population of Physics students in Wukari Metropolis. The purposive sampling technique was employed to select two (2) schools from the twenty (20) schools in Wukari Metropolis, and an intact arm of SS II from each of the sampled schools was used. The schools were randomly assigned to control and experimental groups. The instruments used for data collection was A 20-items Physics Achievement Test (PAT) developed by the researcher. The resulting data were collated and analyzed using mean, standard deviation, and ANCOVA. The finding revealed that students taught with inquiry-based learning achieved better results than students taught using the traditional method. There is a significant difference between the mean Physics achievement scores ($F(1,117)=50.354, p=0.000$, two-tailed) of students taught with IBL and those taught using the traditional method. There is no significant difference in the mean Physics achievement scores of male and female students taught with inquiry based method ($F(1,57)=0.296, p=0.589$, two-tailed). Based on the sequels to the findings, it is concluded that using inquiry-based learning in teaching increases students' engagement and participation, thereby increasing achievement. It's recommended that the Ministry of Education should mount periodic training sessions for teachers on the effective utilization of inquiry-based learning in teaching.

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Corresponding Author:

Fagbenro W. Ayoola

Department of Science Education, Federal University Wukari

Email: ayoola@fuwukari.edu.ng

1. INTRODUCTION

The importance of STEM (science, technology, engineering, and mathematics) education for the long-term success of any nation has been acknowledged by the international community. This suggests that the importance of STEM education for a nation's long-term social, economic, and political development cannot be questioned. A fundamental component of STEM education, physics develops the analytical, critical thinking, and problem-solving abilities necessary for creativity and technological progress (OECD, 2016). It gives students the underlying ideas and rules that govern the natural world, enabling them to take on challenging real-world problems (Fagbenro & Bulus, 2024; Olabiyi, et al., 2021). Students who study physics

gain a deeper grasp of the universe, from the intricacies of quantum mechanics to the rules of motion, which prepares them for professions in engineering, medicine, and renewable energy (Adagonye et al., 2024; Fagbenro & Bileya, 2024).

In addition to engaging students in hands-on activities like conducting experiments to enhance their scientific knowledge and experimental skills, secondary school teachers are expected to assist students in developing a positive attitude toward physics and physics-related phenomena (Adegoke & Ajadi, 2016). Using a variety of teaching and learning techniques, the main goal of education at all levels is to fundamentally transform the students (Fagbenro & Bulus, 2024). Teaching physics presents a special set of difficulties in many different ways. It's a subject that is being discussed and may be appropriately characterized as challenging. Physics is regarded as one of the most challenging courses that students encounter in school, and it is necessary to address students' difficulties with the subject in order to better understand the specific causes of their issues (Candido et al., 2022). It has been discovered that students struggle with the subject's nature, which calls for certain abilities to navigate the range of learning tasks, including employing equations and formulae, problem solving, theoretical and conceptual understanding, spatial reasoning, and experimentation (Bogador et al., 2024). The fact that students must deal with multiple representations at once, including experiments, formulas, and computations, diagrams, words, and conceptual explanations, and must make transformations among them, is linked to their learning difficulties.

Less than 60% of candidates who registered for Physics passed at the distinction and credit levels on average, according to data from the West African Examination Council (WAEC). This suggests that student performance is below expectations when compared to other science subjects like Chemistry and Biology (Ugwuanyi et al., 2020; Ugwuanyi et al., 2021). According to reports from the WAEC Chief Examiners over a number of years, students' shortcomings in physics are caused by misconceptions about scientific principles that affect their performance. A number of recommendations have been made by physics education researchers to improve students' physics achievement: using simulations, multimedia resources, and online platforms to visualize complex concepts and encourage engagement (Rudra, 2024); encouraging peer-to-peer discussions and problem-solving to promote social constructivist learning (Abdul & Basuki, 2025); and encouraging students to explore and discover concepts through hands-on activities and experiments (Bogador et al., 2024).

It has long been acknowledged that inquiry-based learning can lead to improved learning outcomes (Issaka, 2020). According to Kessy and Irene (2021), inquiry-based teaching (IBT) is a pedagogy in which students participate in real scientific inquiry to gain knowledge of the curriculum content, which is delivered by the instructor through inquiry-based activities. Ghumdia and Adams (2017) posit that IBL is a teaching approach where students look for information or understanding about certain phenomena with little assistance from their instructor. According to these viewpoints, inquiry-based learning is a kind of instruction in which students actively participate in the process of obtaining or looking up certain planned knowledge or information using different techniques employed by scientists or inquiry-based activities. These methods include posing queries, developing a hypothesis, making observations, gathering information, documenting and analyzing the findings, and sharing the findings (Kinyota, 2020). Teachers in the inquiry-based approach are guides rather than suppliers. Instead of being recipients of knowledge, students create it. Students can engage with their environment and gain a realistic understanding of abstract phenomena through the inquiry-based approach. Therefore, it promotes a thorough comprehension of the scientific material rather than memorization. This improves performance by extending the retention of taught information in memory (Issaka, 2020). According to a number of studies (Annan et al., 2019; Bailey, 2018; Mohammed, 2014; Ali, 2014; Bogador et al., 2024; Ayakeme & Kolokolo, 2021), inquiry-based instruction has a stronger favourable impact on students' academic attainment.

Females typically have less enthusiasm and faith in physics than males do because of societal prejudices and misconceptions regarding who can achieve in the field (Li & Singh, 2021). Numerous studies have demonstrated that while males' achievement is improved by physics stereotypes, females' performance in the area is negatively impacted (Malespina et al., 2022). According to Malespina et al. (2022), females are more likely to think that they are incapable of learning physics and that the disparity in physics accomplishment between them and males can be partially explained by this belief.

Additionally, some researchers have discovered that students' self-efficacy in learning physics is impacted by physics stereotypes, which in turn affects students' physics accomplishment (Li, 2019). Through a stereotype task experiment, Smith (2004) discovered that females who experience stereotype threat perform lower academically. Also, some researchers have found that misconceptions about physics can increase the procrastinating behaviour of females while decreasing the procrastination behaviour of males (Song et al., 2016). According to Nurulwati et al. (2020), students' learning successes in physics are positively correlated with their self-efficacy. Gender stereotyping might alter students' self-efficacy and further impact learning outcomes, according to Kalender et al. (2020), who examined the relationship between physics self-efficacy and

learning outcomes. According to Malespina et al. (2022), women have more gender stereotypes about physics than men do, and they are more likely to concur that the gap between men's and women's accomplishment in physics is due to their abilities. Research has shown that the association between gender stereotypes in physics and physics achievement is mediated by academic self-efficacy (Li, 2019).

1.1. Inquiry learning/teaching in science education

Focusing on inquiry skills is a relatively new phenomenon in the public education sector, despite the fact that inquiry learning has been used for decades as a teaching and learning technique (Borovay et al., 2019; Zadok-Gurman et al., 2021). According to Dewey (Del Fabbro, 2022; Thayer-Bacon, 2012), scientific education should prioritize teaching science as a way of thinking rather than facts and numbers that students should commit to memory. Joseph Schwab posits that science learning may be a flexible, multidimensional, inquiry-driven manner of thinking and learning rather than a means of drawing definitive conclusions about the world we live in. He further explained that scientific education ought to be more akin to the work of actual scientists. Schwab developed three levels of open inquiry (consuming knowledge without critically engaging with it, asking questions and seeking clarification, and critical thinking and engagement) in accordance with the contemporary divide of inquiry techniques (Del Fabbro, 2022). Students are to be given questions, strategies, and materials in an inquiry-based activity that challenges them to identify connections between variables. This encourages critical thinking so they can use the best learning strategies (such as planning and critical thinking) to come up with their own research methods.

Teachers can initiate inquiry-based learning, a type of active learning, by asking students questions, dilemmas, or scenarios (Enser, 2021; Jong et al., 2022). Unlike traditional education, which frequently depends on the instructor delivering material from their own subject-specific knowledge, inquiry-based learning involves students in a variety of problem-solving skills (Pedaste et al., 2015). Inquiry-based learning places more emphasis on the students' role in the learning process than on the instructor imparting knowledge to motivate them to actively participate. To acquire knowledge or find answers, inquirers identify problems, formulate questions and hypotheses, plan and carry out an experiment, collect and analyze data, and present findings and conclusions (Mäeots et al., 2011). Problem-based learning is a particular type of inquiry-based learning, where the context of learning is presented and experienced through authentic questions and problems within the learner's real world (Kokotsaki et al., 2016). Inquiry-based learning has been found to be tightly associated with the development of student competencies such as critical thinking and problem-solving (Lucietto et al., 2018; McNamara, 2022). The goal of this study is to compare the effect of inquiry-based learning on the physics achievement of male and female senior secondary school II science students in the Wukari Metropolis.

1.2. Research questions (RQ)

- (1) How comparable are the mean achievement scores of students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis?
- (2) How comparable are the mean achievement scores of male and female students taught Physics using inquiry-based learning in Wukari metropolis?
- (3) To what extent does the mean achievement score of male students taught Physics inquiry-based learning differ from those taught using the lecture method in Wukari metropolis?
- (4) To what extent do the mean achievement scores of female students taught Physics using inquiry-based learning differ from those taught using the lecture method in Wukari metropolis?

1.3. Research hypotheses

- (1) There is no significant difference between the mean achievement scores of students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis.
- (2) There is no significant difference between the mean achievement scores of male and female students taught Physics using inquiry-based learning in Wukari metropolis.
- (3) There is no significant difference between the mean achievement scores of male students taught Physics inquiry-based learning and those taught using the lecture method in Wukari metropolis.
- (4) There is no significant difference between the mean achievement scores of female students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis.

2. METHOD

2.1. Research design

The pre-test-post-test non-equivalent control group design, which is a type of quasi-experimental design, was adopted for this study. Since the classes were formed at the beginning of the semester by the school administration, it was not possible to assign students randomly to both experimental and control

groups. But the classes were randomly assigned as the control and experimental groups. The key aspect of this design is that it allows researchers to assess the impact of the intervention by comparing the results of the pre-test and post-test. It helps in determining whether any changes observed can be attributed to the intervention rather than other factors.

2.2. Population of the study

The population of this study consists of all senior secondary school II science students in Wukari metropolis. The choice of SS II students as participants for the study emanated from the fact that SS II students are not preparing for any external examination. It is also assumed that the students would have covered the concept of vectors and addition of vectors in Physics to be able to respond to any question given to them by the researcher. The total number of senior secondary school two science students from all the public secondary schools in Wukari metropolis is 800.

2.3. Sample and sampling techniques

The purposive sampling technique was used to select the two participating schools in Wukari metropolis. One intact science class from each of the two participating schools was used. The two intact classes were randomly assigned to experimental and control groups. The total number of subjects for the study is one hundred and twenty (120).

2.4. Instrument

The instrument used for this study is the Physics Achievement Test (PAT), developed by the researcher. The initial draft of PAT consisted of 16 items. The Physics syllabus prepared for SSCE by WAEC and NECO, as well as the Physics curriculum prepared by the Federal Ministry of Education, Abuja, Nigeria, was taken into consideration. In addition, the items were written by following the pattern of WAEC and NECO. That is, each item was placed on a four-option response mode of A, B, C, and D. The items covered one main topic in Physics, vector and vector addition.

The initial draft of PAT was administered to 50 students. The time allowed for the students to take the test was 20 minutes. On average, it took the students about 16 minutes to finish the test. The item analysis was carried out to select the final items. The item analysis was carried out using CTT. On the basis of the criteria set for the difficulty indices (i.e., $0.30 > p > 0.80$), items that failed to satisfy the conditions were deleted. The final draft of PAT has 10 items.

2.5. Validity of the instruments

Test blue print was developed to ensure the content validity of the test. The thought processes were limited to knowledge, comprehension, and application because of the age of the students, and the inability of the multiple-choice objective question to accommodate learning outcomes such as the ability to articulate explanations, display thought processes, furnish information, organize personal thought, perform a specific task, produce original ideas, and produce examples. Copies of the initial draft of the instrument, lesson plans, and marking scheme were given to three validators. The validations are to ascertain the appropriateness of the instrument, marking scheme, and the lesson notes for the control and experimental groups. They were revised in line with the corrections and recommendations made by the experts before they were used in the selected schools.

2.6. Reliability of the instruments

The instrument was administered to a pilot group of subjects who are part of the target population of the study but not part of the sample. The responses given by the pilot subjects to each individual item were then subjected to analysis to determine the reliability. The test reliability was estimated using the Kuder-Richardson Formula-20 (KR-20). This is because the items are dichotomously scored. This formula is a measure of internal consistency. The reliability coefficient of the instruments was found to be 0.71.

2.7. Data collection procedure

The researcher visited the selected schools to obtain the schools' permission for participation in the study. The Physics Achievement test was employed by the researcher to collect data. The researcher personally taught the classes and administered the instruments to the students with the help of a research assistant. The researcher ensured that all the students started the test at the same time and stopped at the time allotted for the test. All necessary measures were taken to prevent cheating and interaction during the test. The instrument was administered twice, during pre-test and post-test.

Before the experiment started, the students took a pretest. The experimental group received instruction utilizing the IBL during treatment delivery, while the control group received instruction using a traditional technique. Two of the four weeks of the study were dedicated to instructing the students.

2.8. Data analysis

The tests were marked after administration, one (10) mark given for the correct option and no mark given for the incorrect option. The total score obtainable from the test is ten (100) marks. Mean and standard deviation were used for descriptive analysis, and ANCOVA was used to analyze the null hypotheses between

mean scores of experimental and control groups. For the hypotheses, the decision is that the null hypothesis is accepted whenever the value of $P \leq 0.05$.

3. RESULTS AND DISCUSSION

3.1. Research question

Research Question 1: How comparable are the mean achievement scores of students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis?

Table 1. Mean Physics Achievement Score

Teaching Method	N	Mean	Std. Deviation
Inquiry-Based Learning	60	59.7333	9.91637
Traditional	60	55.0000	9.69886
Total	120	57.3667	10.05191

Table 1 shows that the mean Physics achievement score of the students taught with inquiry-based learning is 59.73 with a standard deviation of 9.91, and that of those taught using the traditional method is 55.00 with a standard deviation of 9.69. The mean difference is 4.73. There is a difference in the mean Physics achievement score of students taught with inquiry-based learning and those taught using traditional methods.

The mean Physics achievement score of students taught with inquiry-based learning is higher than the mean Physics achievement score of students taught using the traditional method. This implies that the use of inquiry-based learning in teaching Physics engaged the students and increased their participation, thereby increasing their understanding of the subject matter. This might be due to the way inquiry-based learning activates the cognitive engagement of the learners.

Research Question 2: How comparable are the mean achievement scores of male and female students taught Physics using inquiry-based learning in Wukari metropolis?

Table 2. Mean Physics Achievement by Gender

Teaching Method	Gender	N	Mean	Std. Deviation
Inquiry-Based Learning	male	23	60.0000	11.28152
	Female	37	59.5676	9.12731
	Total	60	59.7333	9.91637

As shown in Table 2, the mean Physics achievement score of male students taught with inquiry-based learning in Physics is 60.0 with a standard deviation of 11.28, while that of the female students taught with inquiry-based learning in Physics is 59.57 with a standard deviation of 9.12. The mean difference is 0.43. Male students taught with inquiry-based learning in Physics slightly achieved better than female students taught with inquiry-based learning in Physics. There is little or no gender difference in the Physics achievement of the students taught with inquiry-based learning.

The male students achieved slightly better than their female counterparts in Physics when the teaching strategy adopted was inquiry-based learning. This implies that the engagement and participation of the male students were aroused and sustained more than that of female students, leading to better achievement than that of female students.

Research Question 3: To what extent does the mean achievement score of male students taught Physics using inquiry-based learning differ from those taught using the lecture method in Wukari metropolis?

Table 3. Descriptive Statistics of Male Students' Physics Achievement between Groups

Teaching Method	Gender	N	Mean	Std. Deviation
Inquiry-Based Learning	Male	23	60.0000	11.28152
Traditional	Male	32	55.0000	9.91903
Total		55	57.0909	10.70180

From Table 3, the mean achievement score of the male students taught with inquiry-based learning in Physics is 60.00 with a standard deviation of 11.28, and that of the male students taught using the traditional method is 55.0 with a standard deviation of 9.92. The mean difference is 10.0. There is a difference between the mean Physics achievement scores of male students taught with inquiry-based learning and those taught using traditional methods.

The study found that there is a difference in the mean Physics achievement scores of female students taught with inquiry-based learning than female students taught using the traditional method. The use of

inquiry-based learning in teaching Physics arouses and sustains the cognitive engagement and participation of female students more than the traditional method.

Research Question 4: To what extent do the mean achievement scores of female students taught Physics using inquiry-based learning differ from those taught using the lecture method in Wukari metropolis?

Table 4. Mean Scores of Female Students' Physics Achievement between Groups

Teaching Method	Gender	N	Mean	Std. Deviation
Inquiry-Based Learning	Female	37	59.5676	9.12731
Traditional	Female	28	55.0000	9.62250
Total		65	57.6000	9.54561

As shown in Table 4, the mean Physics achievement score of female students taught with inquiry-based learning in Physics is 59.57 with a standard deviation of 9.12, while that of the female students taught using the traditional method is 55.0 with a standard deviation of 9.62. The mean difference is 4.57. There is a difference in the mean Physics achievement scores of female students taught with inquiry-based learning and female students taught using the traditional method.

The study found that there is a difference in the mean Physics achievement scores of female students taught with inquiry-based learning than female students taught using the traditional method. The use of inquiry-based learning in teaching Physics arouses and sustains the cognitive engagement and participation of female students more than the traditional method.

3.2. Research hypothesis

Research Hypothesis I: There is no significant difference between the mean achievement scores of students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis.

As shown in Table 1, the mean Physics achievement score of the students taught with inquiry-based learning in Physics ($\bar{X} = 59.73$, $S.D = 9.91$) is more than the mean Physics achievement score of the students taught using the traditional method ($\bar{X} = 55.0$, $S.D = 9.69$). The mean difference between the two conditions was 4.73.

Table 5. ANCOVA Table for Achievement in Physics

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9609.063 ^a	2	4804.532	232.785	.000
Intercept	615.052	1	615.052	29.800	.000
Teaching Meth.	1039.283	1	1039.283	50.354	.000
Pretest	8936.930	1	8936.930	433.005	.000
Error	2414.803	117	20.639		
Total	406936.000	120			
Corrected Total	12023.867	119			

From Table 5, an F -test carried out on the means indicated a significant difference between the mean Physics achievement scores of students taught using inquiry-based learning and those taught using the traditional method ($F(1,117) = 50.354$, $p = 0.000$). The use of inquiry-based learning significantly impacted the Physics achievement scores of the students. The null hypothesis of no significant difference in the mean Physics achievement scores of students taught with inquiry-based learning and those taught using the traditional method is rejected.

The study found that the students taught with inquiry-based learning in Physics achieved better than those taught using the traditional method. From Table 5, an F -test showed that the mean difference between the two conditions is significant. This implies that there is a significant difference in the mean Physics achievement score of students when they are taught using inquiry-based learning. Therefore, the hypothesis of no significant difference in the mean Physics achievement scores of students taught with inquiry-based learning and those taught using the traditional method is rejected.

This finding is in agreement with Abu (2023), Kessy & Irene (2021), Turan et al. (2021), and Sunday et al. (2021), who posit that active learning strategies, such as IBL, promote deeper conceptual understanding than passive learning methods. Traditional learning, which often relies on rote memorization and teacher-centred instruction, may not adequately engage students in critical thinking and hands-on experimentation on key aspects of physics learning. The success of IBL in this study supports the constructivist theory, which emphasizes learning through exploration and inquiry rather than direct instruction

Research Hypothesis II: There is no significant difference between the mean achievement scores of male and female students taught Physics using inquiry-based learning in Wukari metropolis.

As shown in Table 2, the mean Physics achievement score of the male students taught with inquiry-based learning ($\bar{X} = 60.0$, S.D = 11.28) is slightly more than the mean Physics achievement score of female students taught with inquiry-based learning ($\bar{X} = 59.57$, S.D = 9.13). The mean difference between the two conditions is 0.43.

Table 6. ANCOVA Table for Experimental Group by Gender

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4338.876 ^a	2	2169.438	84.532	.000
Intercept	505.129	1	505.129	19.682	.000
Gender	7.593	1	7.593	.296	.589
Pretest	4336.224	1	4336.224	168.960	.000
Error	1462.857	57	25.664		
Total	219886.000	60			
Corrected Total	5801.733	59			

From Table 6, an F-test carried out on the means indicated no significant difference between the mean Physics achievement scores of male students taught using inquiry-based learning and female students taught with inquiry-based learning ($F(1,57) = 0.296$, $p = 0.589$). Male students taught with inquiry-based learning, Physics achievement is not statistically different from that of female students taught with inquiry-based learning. The null hypothesis of no significant difference in the mean Physics achievement scores of male students taught with inquiry-based learning and female students taught with inquiry-based learning is accepted.

The study found that the male students taught with inquiry-based learning in Physics slightly achieved better than the female students taught with inquiry-based learning. From Table 6, an F-test showed that the mean difference between conditions is not significant. This implies that the use of inquiry-based learning in teaching Physics is an equalizer of differences in the engagement and participation of male and female students, resulting in equal achievement. Therefore, the null hypothesis of no significant difference in the mean Physics achievement scores of male students taught with inquiry-based learning and female students taught with inquiry-based learning is accepted. This finding is not in agreement with Song et al. (2016) and Malespinal et al (2022).

This finding contradicts the notion that male students naturally perform better in science-related subjects and supports research indicating that when given equal learning opportunities, female students can perform just as well as their male counterparts. It highlights the importance of engaging instructional methods that eliminate gender disparities in science education.

Research Hypothesis III: There is no significant difference between the mean achievement scores of male students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis.

As shown in Table 3, the mean Physics achievement score of the male students taught with inquiry-based learning ($\bar{X} = 60.0$, S.D = 11.28) is more than the mean Physics achievement score of male students taught using the traditional method ($\bar{X} = 55.0$, S.D = 9.92). The mean difference between the two conditions is 10.0.

Table 7. ANOVA Table for Male between Groups

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4923.732 ^a	2	2461.866	101.535	.000
Intercept	354.302	1	354.302	14.613	.000
Teaching Method	360.872	1	360.872	14.884	.000
Pretest	4589.187	1	4589.187	189.273	.000
Error	1260.813	52	24.246		
Total	185450.000	55			
Corrected Total	6184.545	54			

From Table 7, an F-test carried out on the means indicated a significant difference between the mean Physics achievement scores of male students taught using inquiry-based learning and male students taught using the traditional method ($F(1,52) = 14.884$, $p = 0.000$). Male students taught with inquiry-based learning achieved better than male students taught using the traditional method. The null hypothesis of no significant difference in the mean Physics achievement scores of male students taught with inquiry-based learning and male students taught using the traditional method is rejected.

The results showed that the male students in the experimental group, who were exposed to inquiry-based learning, achieved significantly better results compared to the male students in the control group, who were exposed to the traditional method. The use of inquiry-based learning plays a role in fostering a more positive attitude towards male students' learning of Physics, thereby boosting their academic achievement. The null hypothesis of no significant difference in the mean Physics achievement is rejected. A possible explanation is that IBL encourages hands-on activities, problem-solving, and experimentation, which may appeal to male students' preferences for interactive learning. Unlike traditional methods that rely heavily on theoretical explanations, IBL allows students to actively construct their knowledge, making learning more practical and engaging. This finding is in agreement with Mohammed (2014), Abdi (2014), Bogador (2024), and Ayakeme and Kolokolo (2021).

Research Hypothesis IV: There is no significant difference between the mean achievement scores of female students taught Physics using inquiry-based learning and those taught using the lecture method in Wukari metropolis.

As shown in Table 4, the mean Physics achievement score of the female students taught with inquiry-based learning ($\bar{X} = 59.57$, $S.D = 9.13$) is more than the mean Physics achievement score of female students taught using the traditional method ($\bar{X} = 55.0$, $S.D = 9.62$). The mean difference between the two conditions is 4.57.

Table 8. ANCOVA Table for Female between Groups

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4692.781 ^a	2	2346.390	127.743	.000
Intercept	243.968	1	243.968	13.282	.001
Teaching Method	665.212	1	665.212	36.216	.000
Pretest	4360.262	1	4360.262	237.383	.000
Error	1138.819	62	18.368		
Total	221486.000	65			
Corrected Total	5831.600	64			

From Table 8, an *F*-test carried out on the means indicated that there is a significant difference between the mean Physics achievement scores of female students taught using inquiry-based learning and female students taught using the traditional method ($F(1,62)=36.216$, $p=0.000$). Female students taught with inquiry-based learning achieved better than female students taught using the traditional method. The null hypothesis of no significant difference in the mean Physics achievement scores of female students taught with inquiry-based learning and female students taught using the traditional method is rejected.

The results showed that the female students in the experimental group, who were exposed to inquiry-based learning, achieved better results compared to the female students in the control group, who were taught using a traditional method. The difference in achievement is statistically significant. The null hypothesis of no significant difference between the mean achievement scores of female students taught Physics using inquiry-based learning and those taught using the traditional method is rejected.

This finding is crucial because it challenges the stereotype that female students struggle in physics compared to males. The success of female students in the IBL setting suggests that when provided with a supportive and interactive learning environment, they can excel in science subjects. The collaborative and inquiry-driven nature of IBL likely fosters confidence, engagement, and deeper understanding, contributing to their improved achievement. This finding is in agreement with Mohammed (2014), Abdi (2014), Bogador et al. (2024), and Ayakeme & Kolokolo (2021).

4. CONCLUSION

When compared to traditional learning, inquiry-based learning considerably raises students' physics achievement. IBL appears to benefit both genders equally because there is no significant difference in the academic achievement of male and female pupils. Students who were taught utilizing IBL, both male and female, outperformed those who were taught using conventional methods.

It is advised that educators use IBL techniques when teaching physics. Physics teachers should participate in workshops and training programs in order to successfully apply IBL. This will give them the abilities and information needed to support student-centered learning, create engaging inquiry-based activities, and use cutting-edge evaluation methods to gauge students' progress. The physics curriculum should be reviewed by educational policymakers in order to incorporate inquiry-based teaching techniques. This will encourage the transfer of scientific knowledge from memorization to conceptual comprehension and application. Additionally, schools should supply the infrastructure and resources required to facilitate the adoption of IBL.

Notwithstanding the noteworthy results, it is important to recognize several limitations: Because the study was limited to Wukari Metropolis, the conclusions cannot be applied to other schools with varied student populations. Teachers' experience, teaching abilities, and capacity to lead inquiry-based conversations all play a significant role in how effective IBL is. It may be challenging to determine the actual impact of the teaching strategy since teacher competency may have affected student outcomes.

DECLARATION OF INTEREST

No conflict of interest with regard to this article.

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ETHICAL STATEMENT

This study has followed all known ethical procedures.

AI USE STATEMENT

No use of AI.

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