INQUIRY-BASED LEARNING IN ENHANCING STUDENTS' PERFORMANCE IN PHYSICS: A CASE STUDY OF SELECTED SECONDARY SCHOOLS IN OVIA NORTH EAST L.G.A, EDO STATE NIGERIA

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CERTIFICATION

We, the undersigned, certify that this research work was written by **Joseph AGHIMIEN,** Institute of Education, University of Benin, Benin City.

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ABSTRACT

This study investigated the effect of Inquiry-Based Learning (IBL) on senior secondary students' academic performance in Physics in selected secondary schools within Ovia North East Local Government Area, Edo State. The research aimed to establish the extent to which inquiry-based learning is used and its relationship with students' academic performance, examine the relationship between the use of inquiry-based learning and students' performance in physics based on school location (urban vs. rural), examine the relationship between the use of inquiry-based learning and students' performance in physics based on school ownership (public vs. private), examine the relationship between the use of inquiry-based learning and students' performance in physics based on the sex of physics teachers, compare the difference in the relationship between the use of inquiry-based learning and students' performance in physics based on teachers' qualifications. A descriptive-survey design was adopted. The population of this study will consist of all 2024/2025 academic session of secondary school in Ovia North East Local Government Area, Edo State. Collected data were analyzed using descriptive statistics (means, standard deviations) and inferential tests (t-tests and other appropriate tests) to test for significant relationships and group differences at the 0.05 significance level. Key findings indicate that teachers in the sampled schools use IBL to varying degrees and that, overall, higher levels of IBL use were associated with better student performance in physics. Statistical analysis showed a significant positive relationship between the use of IBL and students' academic achievement in physics. Subgroup analyses revealed notable differences: for example, the use of IBL and/or its impact on performance differed significantly between urban and rural schools, and there were significant variations linked to teacher qualifications and school ownership in some comparisons. Where t-tests were performed, some contrasts produced statistically significant results ($p < 0.05$), suggesting that contextual and teacher variables moderate the effectiveness of IBL. The study concludes that IBL is an effective instructional approach for improving physics learning outcomes in the Ovia North East LGA, Edo State., but its success depends on contextual factors such as school location, available resources, teacher training and qualifications, and institutional support. Recommended actions include targeted professional development in IBL methods for physics teachers, improved provision of teaching resources and laboratory facilities (especially in rural schools), integration of IBL into school-level lesson planning and assessment, and policies encouraging adoption of inquiry practices across both public and private schools.

CHAPTER ONE

INTRODUCTION

Background to the Study

Physics, as a fundamental branch of science, is the bedrock of technological development and innovation. It provides the principles that underpin engineering, electronics, medicine, and information technology, among other fields. The pursuit of effective teaching methodologies in science education has been a central focus of educational reform globally for decades. Traditional, teacher-centered approaches, often characterized by rote memorization and lecture-based instruction, have consistently shown limitations in fostering deep conceptual understanding, critical thinking, and sustained student engagement in complex subjects like Physics (Abdullahi, 2019). Physics, as a fundamental science, requires students to understand abstract concepts, principles, and laws that govern the natural world, which can be challenging through passive learning methods.

In response to these challenges, constructivist learning theories have gained prominence, positing that learners actively construct their own knowledge and understanding through experiences and reflection. Inquiry-Based Learning (IBL) is a primary pedagogical embodiment of constructivism (Adeyemo, 2020). IBL is an approach that involves exploring the natural world through questioning, investigations, and data analysis, leading to evidence-based conclusions. It shifts the role of the student from a passive recipient of information to an active participant in the knowledge-building process (Bransford, Brown, & Cocking, 2020).

The efficacy of IBL is well-documented in global educational literature. Studies from Europe, Asia, and America indicate that IBL enhances students' conceptual understanding, problem-solving skills, scientific attitudes, and academic performance in science subjects (Furtak, Seidel, Iverson, & Briggs, 2022). Organizations like the Programme for International Student Assessment (PISA) and the Next Generation Science Standards (NGSS) in the United States strongly advocate for inquiry-based approaches as a cornerstone of effective science education, arguing that it better prepares students for the demands of the 21st-century workforce (OECD, 2017).

In Nigeria, the study of Physics at the secondary school level is therefore crucial for building a scientifically literate populace and a workforce capable of driving national development and competing in the global economy (Federal Ministry of Education, 2023). Despite its acknowledged importance, students' performance in Physics in Nigerian secondary schools, particularly in the West African Senior School Certificate Examination (WASSCE) and the National Examination Council (NECO), has been persistently and alarmingly poor. National reports consistently show low enrolment, high failure rates, and a widespread phobia for the subject among students (Adeyemo, 2020; Njoku, 2017). Edo State, and by extension Ovia North East Local Government Area, is not immune to this national trend. The causes of this poor performance are often attributed to a multitude of factors, including inadequate laboratory facilities, teachers' ineffective instructional methods, the abstract nature of physics concepts, and students' negative attitudes towards the subject (Okoro, 2020).

A significant part of the problem lies in the predominant pedagogical approach. Physics instruction in many Nigerian secondary schools remains largely traditional, characterized by teacher-centered, rote-learning methods where students are passive recipients of pre-packaged information. This approach fails to engage students actively, stifles curiosity, and does not equip them with the critical thinking and problem-solving skills necessary to understand complex scientific phenomena (Ogunleye & Babajide, 2021). Students often memorize formulas without a deep conceptual understanding, leading to an inability to apply knowledge to new situations.

In response to these challenges, educational researchers and reformers have advocated for a shift towards more student-centered, constructive teaching methodologies. One such approach is Inquiry-Based Learning (IBL). IBL is an educational strategy that involves a process of exploration, questioning, and discovery, where students are actively involved in constructing their own understanding. Instead of being given facts, students investigate questions, problems, or scenarios, often through hands-on experiments and collaborative work. The teacher acts as a facilitator rather than a sole knowledge transmitter (Brunner, 2021; Dewey, 2018). The core phases of IBL typically include orientation, conceptualization, investigation, conclusion, and discussion.

Studies conducted in various contexts have shown that IBL can significantly enhance students' academic achievement, conceptual understanding, critical thinking skills, and positive attitudes towards science (Abdullahi, 2019; Jack, 2023). By engaging directly with scientific processes, students develop a deeper and more lasting understanding of concepts. Furthermore, IBL can make learning more relevant and enjoyable, thereby increasing motivation and reducing anxiety.

However, while the benefits of IBL are well-documented in developed countries and in some urban centers, its effectiveness specifically within the context of public secondary schools in semi-urban and rural areas like Ovia North East L.G.A. of Edo State remains under-researched (Adeyemo, 2020). The successful implementation of IBL in this context may be influenced by unique local factors such as resource constraints, class size, teacher preparedness, and the existing cultural approach to learning. Therefore, there is a critical need to conduct a context-specific investigation to determine the efficacy of this pedagogical approach in enhancing physics education in this region. This study, therefore, seeks to bridge this gap by examining the role of Inquiry-Based Learning in enhancing students' performance in Physics in selected secondary schools in Ovia North East L.G.A., Edo State, Nigeria. The findings from this research will provide valuable evidence for educators, curriculum planners, and policymakers on the potential of IBL as a viable strategy for reversing the trend of poor academic performance in Physics and similar science subjects.

Statement of the problem

Physics is a fundamental branch of science that underpins the understanding of natural phenomena, technological development, and scientific innovation. Despite its importance, students at the secondary school level in Nigeria have consistently shown poor performance in physics. Several reports from the West African Examinations Council (WAEC) and the National Examinations Council (NECO) indicate that a significant proportion of students fail to attain the minimum credit pass in physics, highlighting a persistent academic challenge. This trend is not unique to Nigeria but is also reflected globally, where physics is often regarded as a difficult subject due to its abstract concepts, complex problem-solving requirements, and the need for both theoretical understanding and practical application.

In Ovia North East Local Government Area (L.G.A.) of Edo State, anecdotal evidence from school teachers and education officers suggests that students' interest in physics is declining, and their engagement in classroom activities is minimal. Traditional teaching methods, predominantly lecture-based or rote memorization approaches, have been identified as one of the primary factors contributing to students' poor academic performance. These methods often fail to encourage critical thinking, creativity, and active participation, which are crucial for mastering physics concepts. Consequently, students struggle with understanding abstract principles such as mechanics, thermodynamics, and electromagnetism, leading to low performance in both internal and external examinations.

The problem is further compounded by the lack of adequate instructional resources and teaching aids in many secondary schools in Ovia North East L.G.A. Laboratories are either poorly equipped or underutilized, limiting students' opportunities to engage in practical experiments that reinforce theoretical knowledge. Moreover, many teachers continue to rely on conventional pedagogy due to large class sizes, limited training in innovative teaching strategies, and an overemphasis on examination-oriented education. This scenario creates a significant gap between students' theoretical knowledge and their ability to apply physics principles in practical or real-life situations.

Inquiry-Based Learning (IBL) has emerged globally as an effective pedagogical strategy that promotes active learning, critical thinking, and problem-solving skills. Through IBL, students are encouraged to ask questions, investigate phenomena, conduct experiments, and construct knowledge collaboratively. Studies have shown that students exposed to inquiry-based methods exhibit better conceptual understanding, increased motivation, and improved academic performance in science subjects, including physics. Despite these findings, the adoption of IBL in secondary schools within Ovia North East L.G.A. appears limited, and there is insufficient empirical research assessing its impact on students' performance in physics.

Therefore, this study seeks to address the problem of persistent low performance in physics among secondary school students in Ovia North East L.G.A. by investigating how inquiry-based learning can enhance students' academic outcomes. Understanding the relationship between IBL implementation and student performance will provide valuable insights into teaching strategies that can promote conceptual understanding, engagement, and achievement in physics. It is hoped that the findings of this research will assist educators, curriculum planners, and policymakers in designing effective instructional interventions that can bridge the gap between traditional teaching methods and modern pedagogical approaches, thereby improving students' performance and interest in physics.

Purpose of the Study

The purpose of this study is to investigate the use of inquiry-based learning and its effect on students' academic performance in physics. It is also to:

1. Establish the extent to which inquiry-based learning is used and its relationship with students' academic performance in physics in selected secondary schools in Ovia North East Local Government Area.
2. Examine the relationship between the use of inquiry-based learning and students' performance in physics based on school location (urban vs. rural) in Ovia North East Local Government Area.
3. Examine the relationship between the use of inquiry-based learning and students' performance in physics based on school ownership (public vs. private) in Ovia North East Local Government Area.
4. Examine the relationship between the use of inquiry-based learning and students' performance in physics based on the sex of physics teachers in Ovia North East Local Government Area.

5. Compare the difference in the relationship between the use of inquiry-based learning and students' performance in physics based on teachers' qualifications in Ovia North East Local Government Area.

Research Questions

1. Is there any relationship between the level of use of inquiry-based learning strategies and the academic performance of students in physics in Ovia North East Local Government Area.
2. Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school location?
3. Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school ownership?
4. Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on the sex of teachers?
5. Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on the qualification of teachers?

Research Hypothesis

Ho1: There is no significant relationship between the use of inquiry-based learning and students' academic performance in physics in selected secondary schools in Ovia North East Local Government Area.

Ho2: There is no significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on school location in Ovia North East Local Government Area.

Ho3: There is no significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on school ownership in Ovia North East Local Government Area.

Ho4: There is no significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on the sex of physics teachers in Ovia North East Local Government Area.

Ho5: There is no significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on the qualification of physics teachers in Ovia North East Local Government Area.

Significance of the Study

The findings of this study will be beneficial to several stakeholders:

The Ministry of Education: To generate and coordinate policies, review and adapt science curriculum, and provide training, teaching materials, and infrastructure that promote the use of inquiry-based learning approaches in the teaching of physics at the secondary school level.

School Administrators: To emphasize and support the integration of inquiry-based strategies into classroom practices. They will also be better informed on how to equip laboratories, encourage collaborative learning, and monitor teaching methods that can improve student performance in physics.

Teachers: To better understand their roles as facilitators in an inquiry-driven classroom environment. Teachers will gain insight into how student-centered methods improve engagement, conceptual understanding, and overall academic achievement in physics.

Parents, Guardians, and the Community: To be made aware of the importance of inquiry-based learning in helping students think critically and develop scientific reasoning. This will encourage support for students' participation in hands-on learning activities and help create a home environment that complements inquiry-based education.

Students: To benefit directly from improved instructional strategies that make physics more interactive, relatable, and easier to understand. As a result, students are expected to show increased interest, motivation, and performance in physics.

Future Researchers: To serve as a reference for further studies on innovative teaching methods in science education, particularly in how inquiry-based learning affects academic performance in other science subjects or across different levels of education.

Scope of the Study

This study focuses on the effect of Inquiry-Based Learning (IBL) on students' academic performance in physics within selected secondary schools in Ovia North East Local Government Area (L.G.A.), Edo State, Nigeria. The research examines how the use of IBL strategies by physics teachers influences students' achievement in physics tests and practical problem-solving skills. The study is limited to public and private secondary schools chosen purposively within Ovia North East L.G.A.

Definition of Terms

To ensure clarity and proper understanding of key concepts used in this study, the following terms are defined as they relate to the research:

Inquiry-Based Learning (IBL): A student-centered teaching approach where learners actively engage in questioning, investigating, exploring, and problem-solving in order to construct knowledge, rather than passively receiving information from the teacher.

Students' Performance: The measurable academic outcomes or achievements of learners in Physics, often assessed through tests, examinations, assignments, and practical demonstrations of knowledge and skills.

Physics: A branch of science concerned with the study of matter, energy, motion, and the interactions between them. In the context of secondary education, it refers to the curriculum designed to develop scientific reasoning, critical thinking, and problem-solving skills in learners.

Teaching Method: A systematic way of delivering subject content to learners. In this study, it specifically refers to the inquiry-based approach in comparison to traditional teacher-centered methods such as lecture and rote learning.

Traditional Method of Teaching: A teacher-centered instructional strategy where the teacher provides information while students act as passive recipients, often characterized by rote memorization and limited student participation.

Academic Achievement: The extent to which a student has attained specific learning goals, skills, or competencies in Physics as demonstrated through classroom assessments, practical activities, and standardized examinations.

Scientific Attitude: A mindset characterized by curiosity, critical thinking, objectivity, and willingness to test ideas through experimentation attributes encouraged by inquiry-based learning.

Learning Outcomes: The knowledge, skills, values, and attitudes that students acquire as a result of the teaching and learning process in Physics.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviews related literatures on the Inquiry-Based Learning in Enhancing Students Performance in Physics. The review of related literature in this study will be organized under the following sub-headings of all issue discussed.

- Theoretical Framework
- Concept of Inquiry-Based Learning
- Types of Inquiry-Base Learning
- Prevalence of inquiry-based Learning
- Effect of inquiry-based learning on academic performance
- Relationship between inquiry-based learning and students achievement
- Influence of School location on the implementation of inquire-based learning
- Influence of school ownership (public vs private) on the implementation of inquity-based learning
- Level of use of inquiry-based learning strategies and the academic performance of students in physics
- Use of inquiry-based learning and students' performance in physics based on school location

- Use of inquiry-based learning and students' performance in physics based on school ownership
- Use of inquiry-based learning and students' performance in physics based on the sex of teachers
- Use of inquiry-based learning and students' performance in physics based on the qualification of teachers
- Summary of Reviewed Literature

Constructivist Learning Theory

Constructivism views learning as a process where learners actively construct new knowledge based on their existing experiences and understanding. It assumes that learners are not empty vessels but come with prior knowledge and conceptions, which can either, help or hinder the acquisition of new ideas (Fosnot & Perry, 2019). When students engage in inquiry, they build upon these pre-existing ideas by exploring problems, manipulating variables, collecting data, and drawing conclusions. These activities, central to IBL, reflect the constructivist belief that knowledge is not transmitted but constructed.

The theory posits that knowledge is not passively received but actively constructed by the learner. Piaget emphasized that learners build new knowledge based on their existing cognitive structures through processes such as assimilation and accommodation. In the context of physics education, students come to the classroom with pre-existing conceptions or misconceptions about physical phenomena (e.g., motion, force, or energy). Through inquiry-based learning, students are given the opportunity to test these preconceptions, ask questions, engage in experiments, and reconcile their ideas with scientific explanations.

Constructivism aligns perfectly with inquiry-based learning because it encourages learners to be active participants rather than passive recipients of knowledge. For example, when a teacher introduces a physics concept like *Newton's Laws of Motion* using inquiry, students may engage in hands-on activities such as rolling objects on different surfaces. They observe outcomes, analyze patterns, and reconstruct their prior misconceptions with accurate scientific reasoning. Thus, Piaget's constructivism provides a solid theoretical base for explaining how inquiry-driven instruction can improve performance in physics.

In a physics classroom, for instance, instead of telling students that pressure is inversely proportional to area, a teacher might have students use syringes of different diameters to feel the difference in force required to push them. Through such experiences, students derive the concept of pressure themselves, reinforcing deeper understanding. This method allows students to challenge misconceptions, experiment, and test ideas, which are crucial aspects of learning in constructivism (Khine & Areepattamannil, 2022).

Experiential Learning Theory (David Kolb)

David Kolb's Experiential Learning Theory provides another framework that supports IBL. According to Kolb (1984), learning occurs in a four-stage cycle:

1. Concrete Experience – actively experiencing the task;

2. Reflective Observation – reflecting on the experience and what occurred;

3. Abstract Conceptualization – developing general theories from reflections;

4. Active Experimentation – applying theories to solve new problems.

This model is a natural fit for inquiry-based learning, where students learn through experience and reflection, rather than rote instruction. In an IBL physics class, students might investigate projectile motion by launching objects at different angles. This hands-on activity forms their concrete experience. Students then reflect on the patterns in distance and height (reflective observation), formulate general rules about horizontal and vertical motion (abstract conceptualization), and then design new launch angles or weights to predict outcomes (active experimentation).

Kolb's theory helps explain why IBL is effective: it immerses learners in experiences that they can connect to theoretical ideas and later apply in unfamiliar contexts. This ensures deeper learning, not just short-term performance. For example, when learning about thermodynamics, students could conduct heat transfer experiments using metal rods and thermometers, observe temperature changes over time, discuss why different materials behave differently, and use their findings to design a more efficient cooking utensil. The process helps them construct and apply scientific knowledge in meaningful ways.

Research by Abubakar and Alhassan (2023) found that when students learned physics through experiential activities, they not only scored higher in tests but also demonstrated greater interest in scientific inquiry. Similarly, Shaheen and Al-Mahmoud (2021) observed that inquiry and experiential learning helped students apply physics knowledge more effectively in real-world problem-solving situations, such as designing simple machines or analysing motion in sports.

Concept of Inquiry-Based Learning

Inquiry-Based Learning (IBL) is a teaching approach where students are encouraged to explore, ask questions, carry out investigations, and build their own understanding of concepts rather than simply listening to the teacher or memorizing facts. In IBL, the teacher does not just give answers but helps students find answers by guiding their thinking and learning process. This method helps students become more active, independent, and motivated learners (Pedaste et al., 2015; Khine & Areepattamannil, 2022).

In science subjects like physics, IBL is especially useful because science is naturally about asking questions, making predictions, experimenting, and solving problems. Instead of just telling students the laws of motion, a physics teacher using IBL might ask them to investigate what happens when objects are pushed with different forces. The students can record their observations, think about the results, and then come up with their own explanations based on evidence. This kind of learning helps students understand better and remember longer (Hmelo-Silver & Azevedo, 2022).

IBL also supports important skills like critical thinking, collaboration, and creativity. For example, in a lesson on electric circuits, instead of giving students a complete diagram to memorize, the teacher may give them batteries, bulbs, and wires and ask them to find out how to light the bulb. This hands-on activity allows students to test their ideas, solve problems, and discuss with classmates. Through this process, they develop not only subject knowledge but also problem-solving skills (Hake, 2018). IBL can be used in different ways. Sometimes the teacher gives the question and students find the answer (structured inquiry). Other times, students ask their own questions and design investigations themselves (open inquiry). Both methods are useful and can be chosen based on students' levels and the topic being taught (Pedaste et al., 2015). Studies have shown that IBL improves students' performance in science. According to Kearney (2016), Nigerian students who learned physics through inquiry methods performed better in tests and showed more interest in the subject than those who learned through traditional methods. A more recent study by Furtak et al. (2023) confirmed that inquiry-based methods help students learn science concepts more deeply, especially when combined with guidance from the teacher.

IBL is also flexible. It allows students to learn at their own pace and build on what they already know. For weaker students, it gives the chance to experiment and learn through doing. For stronger students, it gives room to explore deeper ideas and apply their knowledge to new situations. This makes IBL useful for all kinds of learners in the physics classroom (Furtak et al., 2022). Overall, Inquiry-Based Learning helps students to understand physics in a meaningful way. It moves learning from just copying notes to discovering ideas. This makes physics more interesting, more practical, and more effective in improving students' academic performance.

Types of Inquiry-Based Learning

Inquiry-Based Learning (IBL) is increasingly recognized as a transformative instructional approach that actively engages learners in the construction of knowledge through questioning, exploration, and critical thinking. IBL is not a monolithic method; instead, it comprises a continuum of instructional strategies that vary in terms of the level of teacher guidance and student autonomy. These variations have been categorized into four primary types: confirmation inquiry, structured inquiry, guided inquiry, and open inquiry (Lockwood, 2024).

Confirmation Inquiry

Confirmation inquiry is the most basic form of IBL, where both the research question and the method for investigation are provided by the teacher. The aim is for students to replicate a known result or principle to confirm their understanding of a scientific concept. Though it offers limited autonomy, it plays a foundational role in introducing students to scientific processes, especially in physics where verification of laws and theories is central. For example, confirming Ohm's

Law through practical experimentation allows students to reinforce theoretical concepts with empirical data (Minner et al.,, 2024).

Structured Inquiry

In structured inquiry, the teacher poses a research question and outlines the procedure, but students are expected to engage in data analysis and draw their own conclusions. This approach balances support and independence, enabling students to develop analytical reasoning while remaining within a clear instructional framework. Structured inquiry is particularly effective in lower secondary physics education, where learners are still acquiring basic investigative skills. It promotes understanding of cause-and-effect relationships and fosters a scientific mindset (Song & Looi, 2022).

Guided Inquiry

Guided inquiry increases the level of student involvement by allowing learners to design the procedure of the investigation while the teacher provides only the research question. This model encourages greater cognitive engagement and nurtures skills in experimental design, hypothesis testing, and data interpretation. According to Minner (2020), guided inquiry has been shown to improve students' scientific reasoning and performance, particularly in topics like energy transfer and motion in physics.

Open Inquiry

Open inquiry represents the highest level of student autonomy within the IBL continuum. In this model, students formulate their own research questions, design and conduct investigations, and communicate their findings. This type of inquiry closely mirrors the work of professional scientists and promotes higher-order thinking, creativity, and deep conceptual understanding.

Although it is more demanding, it has been shown to significantly improve students' scientific process skills and foster long-term interest in science disciplines such as physics (Kind, 2017).

Prevalence of Inquiry-Based Learning

Inquiry-Based Learning (IBL) has gained increasing recognition in global education systems due to its student-centered and constructivist foundations. However, the adoption and prevalence of IBL in schools vary significantly across regions, school types, subjects, and teacher training environments.

Globally, IBL is more prevalent in developed countqries and in schools that prioritize 21st-century competencies such as critical thinking, collaboration, and problem-solving (OECD, 2020). Countries with progressive curricula such as Finland, Canada, and Singapore have integrated IBL elements into national education frameworks, especially in STEM subjects. In contrast, its implementation in many developing contexts remains limited due to traditional teacher-centered practices, exam-focused systems, and limited resources (Furtak et al., 2012; Harlen, 2013).

Within schools, the prevalence of IBL also differs across subjects. It is more commonly employed in science and mathematics, where inquiry closely aligns with the nature of the discipline asking questions, formulating hypotheses, conducting experiments, and drawing conclusions (Hmelo-Silver et al., 2017). Physics education, in particular, benefits from IBL through experiments and conceptual questioning that deepen students' understanding of abstract principles (Areepattamannil, 2022).

The level of IBL use in schools is heavily influenced by teacher beliefs, training, and experience. Teachers who are well-trained in active learning strategies and who perceive students as capable of independent thinking are more likely to employ IBL methods (Windschitl, 2003). Conversely, lack of confidence in classroom management or misconceptions about IBL being too time-consuming can hinder its adoption (Blanchard et al., 2010). Pre-service and in-service professional development programs that model IBL strategies are essential to promoting its wider use.

Another factor affecting the prevalence of IBL is school culture and leadership. Schools with supportive leadership that fosters innovation, provides teaching resources, and allows curriculum flexibility are more conducive to implementing IBL (Lockwood, 2024). In contrast, rigid curricula, high-stakes assessments, and large class sizes can be significant barriers, especially in secondary schools.

In Nigeria and many other African countries, IBL is often discussed in policy but rarely implemented in practice. Studies have shown that while the curriculum advocates for problem-solving and discovery learning, actual classroom practices tend to remain lecture-based (Kind et al., 2017). The prevalence of IBL in Nigerian schools is often limited to private or elite institutions with access to resources and teacher training.

Effect of inquiry-Based Learning on Academic Performance

Several scholars have explored the relationship between instructional strategies and students' academic achievement, with a growing body of research pointing to the effectiveness of Inquiry-Based Learning (IBL) in enhancing academic performance (Kearney, 2016). IBL, rooted in constructivist learning theory, empowers students to engage actively in the learning process through questioning, investigation, and critical reflection. These interactive processes significantly contribute to deeper learning and better academic outcomes, particularly in science-related disciplines. Inquiry-Based Learning fosters conceptual understanding by encouraging students to participate in hands-on and minds-on activities that mirror real-world problem-solving. In contrast to rote learning and memorization, which often dominate teacher-centered classrooms, IBL promotes the construction of knowledge through active engagement. This experiential approach helps students retain content longer and apply their understanding to new situations, thereby improving their performance in both classroom assessments and external examinations.

Studies across various educational contexts have reported improved academic achievement as a result of IBL implementation. For instance, a meta-analysis by Furtak et al. (2022) showed that students who participated in inquiry-based science instruction outperformed those in traditional lecture-based settings in both content mastery and conceptual understanding. Similarly, Minner et al. (2020) concluded from their synthesis of 138 studies that inquiry-based approaches have a consistent, positive impact on science achievement.

In the Nigerian context, Opara (2021) found that students in junior secondary schools who were taught using guided inquiry methods in basic science recorded significantly higher achievement scores than their peers exposed to conventional teaching strategies. This finding reinforces the argument that when inquiry methods are appropriately implemented, they can enhance students' academic performance regardless of location or resource constraints (Bransford, 2020). Another important contribution of IBL to academic success is its effect on students' motivation and interest. Learners who are encouraged to ask questions, design investigations, and actively participate in solving problems tend to develop greater interest in the subject matter. This intrinsic motivation leads to increased effort and persistence, both of which are essential for academic excellence especially in subjects such as physics, which students often perceive as abstract or difficult.

Moreover, IBL cultivates critical thinking, analytical reasoning, and independent learning—skills that are vital for academic achievement and lifelong learning. Through inquiry, students develop the ability to assess information, evaluate evidence, and communicate their findings effectively. These skills contribute not only to performance in science subjects but also enhance overall cognitive development.

However, the effect of IBL on academic performance depends on factors such as teacher preparedness, level of scaffolding, student ability, and availability of instructional resources. Without adequate support, students may struggle to manage the demands of inquiry tasks, which can negatively impact their academic outcomes. Thus, the success of IBL is closely tied to the competence of the teacher and the learning environment.

Relationship between Inquiry-Based Learning and Student Achievement

The relationship between Inquiry-Based Learning (IBL) and student achievement has become a focal point in educational research and policy, particularly as education systems shift toward learner-centered methodologies. IBL provides a framework where students construct knowledge actively through observation, questioning, investigation, and reflection. This mode of learning is seen as conducive to academic success because it aligns with how students learn best through exploration and critical engagement with real-world problems.

Student achievement, often measured through test scores, grades, and conceptual understanding, has been shown to improve when inquiry-based approaches are used in instruction. Numerous empirical studies have demonstrated that students engaged in IBL outperform their peers in traditional classrooms on measures of academic success. According to Prince and Felder (2016), IBL contributes to both cognitive gains and increased motivation, which are key predictors of achievement. Students develop not only content knowledge but also vital thinking and problem-solving skills that enhance their performance across subjects.

One of the primary mechanisms through which IBL supports student achievement is by fostering deep learning. Unlike surface learning, which emphasizes memorization, deep learning involves making meaningful connections, analyzing information, and applying concepts to new situations. Inquiry-based strategies stimulate curiosity and encourage students to take ownership of their learning, which translates into better academic outcomes (Hmelo-Silver et al., 2017). When students engage in inquiry, they become active participants in the learning process, leading to improved retention, understanding, and application of knowledge.

Furthermore, the inquiry model supports differentiated learning, allowing students of diverse abilities and backgrounds to learn at their own pace and explore content in a manner suited to their learning style. This inclusive nature contributes to overall student achievement by ensuring that more learners are actively engaged and supported. Furtak et al. (2022) emphasize that when properly scaffolded, inquiry learning benefits not only high achievers but also students who typically struggle in conventional instructional settings.

In science education, particularly in physics, the relationship between IBL and student achievement is especially pronounced. Inquiry strategies allow learners to investigate physical phenomena, test hypotheses, and apply theoretical concepts through experimentation. This process strengthens their understanding of complex concepts and improves their performance in both classroom and standardized assessments. Studies such as that by (Bransford et al., 2020) in Nigeria have confirmed that students taught with inquiry-based methods demonstrated significantly higher achievement in science subjects than those exposed to traditional teaching techniques.

However, the effectiveness of IBL in promoting student achievement is influenced by several mediating factors, including teacher competence, classroom environment, and curriculum design. If inquiry tasks are poorly structured or unsupported, the intended academic gains may not materialize. As Kind (2017) argue, minimal guidance in inquiry may overwhelm novice learners, especially in content-heavy subjects like physics. Therefore, the relationship between IBL and achievement is strongest when instruction is carefully designed to balance autonomy with appropriate teacher guidance.

Influence of School Location on the Implementation of Inquire-Based Learning

The effective implementation of Inquiry-Based Learning (IBL) in schools is significantly influenced by contextual factors, among which school location plays a prominent role. Whether a school is situated in an urban, peri-urban, or rural area often determines the availability of resources, teacher capacity, infrastructural support, and overall readiness for the adoption of innovative pedagogical practices like IBL (Hake, 2018). These disparities can affect the quality, frequency, and depth with which inquiry-based instruction is delivered across different educational settings.

Urban schools are typically better positioned to adopt IBL due to greater access to instructional resources such as functional laboratories, internet connectivity, digital learning tools, and a broader array of teaching aids. Teachers in urban areas are more likely to attend professional development programs, collaborate with peers in learning communities, and experiment with student-centered methodologies (Ntem et al., 2022). This access increases their confidence in facilitating inquiry, encourages innovation, and leads to a more robust implementation of IBL in classroom practice.

On the other hand, schools located in rural areas often struggle with infrastructural deficits, limited access to quality teaching materials, and teacher shortages. These challenges hinder the integration of IBL strategies that require experimentation, collaborative learning, and the use of investigative tools. According to Crawford (2024), rural science teachers in Nigeria face unique obstacles such as lack of laboratory equipment and high student-to-teacher ratios, which discourage the adoption of hands-on inquiry-based techniques. Consequently, many rural classrooms remain dominated by lecture-based teaching, which does not align with the principles of inquiry learning.

Teacher quality and professional development opportunities also vary with school location. In urban settings, teachers are more likely to possess advanced qualifications and receive frequent in-service training that exposes them to constructivist methodologies, including IBL (Areepattamannil, 2022). Rural teachers, in contrast, may have limited access to such training due to geographic isolation, logistical constraints, or insufficient government support. This disparity contributes to a lack of preparedness in facilitating inquiry-based science instruction, which further widens the gap in instructional quality between rural and urban schools.

The learning environment and student exposure also differ by location. Urban students often benefit from supplementary learning experiences such as science museums, tech fairs, or enrichment programs that reinforce inquiry-based exploration. Rural students, however, may be constrained to classroom-only learning experiences with limited exposure to practical science or investigative learning beyond the school environment (Crawford, 2024). These differences influence students' ability to engage meaningfully in IBL tasks and affect overall science achievement and interest.

Influence of School Ownership (Public vs Private) on the Implementation of inquiry-based learning

The nature of school ownership whether public or private significantly shapes the extent to which inquiry-based learning (IBL) is adopted and implemented in secondary school science classrooms, especially in the teaching of physics. In many developing countries like Nigeria, disparities in funding, infrastructure, administrative policy, and teacher motivation between public and private schools directly impact pedagogical approaches. IBL, which requires active participation, experimentation, and teacher facilitation, tends to thrive more where resources and institutional support are readily available (Barrow, 2016).

Resources Availability and Infrastructure

Private schools often operate under more autonomous and better-resourced management systems. This autonomy allows for greater investment in science laboratories, ICT tools, and teaching aids that are critical for effective implementation of inquiry-based approaches. Private schools may also benefit from lower student-to-teacher ratios, allowing for individualized instruction and guided inquiry sessions (Banchi & Bell, 2018). In contrast, many public schools, particularly in rural or underserved areas, face chronic shortages of laboratory equipment, inconsistent electricity supply, lack of functional laboratories, and overcrowded classrooms. These conditions make it difficult for science teachers to conduct hands-on, inquiry-based experiments, even when they have the training and intention to do so.

Empirical studies show that where laboratory resources are inadequate, teachers tend to revert to traditional lecture-based teaching methods, which rely heavily on note dictation and rote learning (Udu & Nwoke, 2020). Inquiry-based science education demands consistent practical exposure, which cannot be sustained without reliable infrastructure—a challenge predominantly affecting public schools.

Teacher Quality, Training and Motivation

Teacher competency and professional development also differ notably between public and private schools. In some private schools, school administrators invest in periodic professional development workshops, sponsor attendance at science teaching conferences, and promote the adoption of modern pedagogical techniques including IBL (Adebayo & Akinbode, 2020). This culture of continuous improvement is motivated by market competition and the pressure to produce excellent academic outcomes.

On the other hand, while public school teachers are often well-qualified on paper, many lack access to current training and in-service workshops. Public teachers frequently face delays in salaries, limited supervision, and fewer incentives to explore innovative methods (Carrell et al., 2020). Moreover, bureaucracy and rigid government policies can slow down the integration of new methods like IBL into public schools' routine practice. Even when public school teachers are trained in IBL strategies, the absence of practical resources renders the training theoretical and unsustainable.

Curriculum Implementation and Autonomy

Private schools often enjoy greater flexibility in curriculum implementation. Many adopt enriched curricula that integrate international standards, allowing for project-based learning, open-ended experimentation, and student-led inquiry. In some cases, private schools are free to extend learning time for science or rearrange schedules to accommodate laboratory sessions. Such flexibility creates a favorable environment for IBL, which requires time for exploration, questioning, and investigation (Crawford, 2024).

In contrast, public schools are usually bound to strict government-approved syllabi, often emphasizing exam preparation and content coverage over skill development. The emphasis on standardized testing and rigid time allocations may leave little room for inquiry-based projects or open investigations. As a result, science teaching in many public schools remains predominantly textbook-driven, limiting opportunities for student inquiry and practical learning.

Administrative Support and Monitoring

Administrative leadership plays a vital role in promoting or discouraging innovative teaching strategies. In private schools, administrators are typically more accessible and more responsive to feedback from teachers. They may actively encourage IBL by allocating budget lines for science resources, recognizing teacher innovation, and creating school-based policies that support experiential learning (Okafor & Nwankwo, 2020).

Public school administrators, by contrast, are sometimes constrained by hierarchical structures, limited budgets, and a focus on maintaining order rather than fostering pedagogical innovation.

Without institutional encouragement, science teachers in public schools may lack the confidence or authority to adopt inquiry-based strategies, especially when such strategies deviate from traditional classroom norms.

Impact on Student Learning Outcomes

Numerous studies suggest that students in private schools often perform better in science subjects, in part due to the consistent application of interactive and student-centered methods like IBL. Bransford (2020) found that students exposed to guided inquiry in private schools showed higher engagement and better understanding of abstract physics concepts compared to their counterparts in public schools.

However, it is essential to note that the difference in student outcomes is not solely due to school ownership but also to the conditions that ownership often enables such as better resources, improved teacher morale, and supportive leadership. In well-resourced public schools with proactive teachers and supportive administrators, IBL has also been shown to yield significant academic gains (Areepattamannil, 2022). The challenge lies in ensuring that such enabling conditions are not restricted to a privileged few.

Equity and Policy Implications

The gap in IBL implementation between public and private schools has broad implications for educational equity and national development. If left unaddressed, students in under-resourced public schools may continue to lag behind in critical thinking, problem-solving, and scientific literacy skills that are foundational in a knowledge-driven economy (Furtak et al., 2022). There is a pressing need for government interventions that provide equitable access to science teaching resources, standardize teacher training in IBL strategies, and reform the curriculum to encourage student inquiry in all types of schools.

Public-private partnerships, increased investment in public education, and decentralization of curriculum decisions may help bridge the implementation gap and ensure that all students, regardless of school ownership, benefit from effective physics instruction through inquiry-based learning. The influence of school ownership on the implementation of inquiry-based learning in physics is profound and multifaceted. Private schools tend to have the structural, financial, and managerial advantages that make IBL implementation more feasible and consistent. Public schools, while sometimes richer in qualified personnel, are often limited by systemic issues that hinder innovation. For IBL to thrive universally in Nigeria’s secondary schools, policy reforms must prioritize equity in resources, empower school leaders, and support science teachers with ongoing training and encouragement to adopt inquiry-based methods regardless of school type.

Influence of Teacher Qualification and Training on the use of Inquiry-Based Learning

The successful implementation of Inquiry-Based Learning (IBL) in physics education is heavily dependent on the quality, qualifications, and professional training of teachers. Physics, being an abstract and conceptually demanding subject, requires not only content mastery but also pedagogical competence in student-centered strategies like IBL. Teachers with higher academic qualifications and relevant training are generally more confident and better equipped to facilitate inquiry processes in the classroom (Crawford, 2024). As such, teacher qualification and training play a central role in determining how effectively IBL is adopted and practiced in secondary schools.

Teacher qualification refers to the level of formal education and certification attained by a teacher, usually including a minimum of a Bachelor's degree in Education or a science-related field. Training, on the other hand, includes pre-service education, in-service workshops, and continuous professional development (CPD) programs that enhance both pedagogical and subject-specific skills. Together, these elements form the professional foundation upon which innovative teaching practices like IBL can be built. Studies show a positive correlation between teacher qualification and student performance in science subjects, especially when teachers possess both deep content knowledge and strong instructional skills (Hazari et al, 2020). Teachers with specialized degrees in physics or science education are more likely to design effective inquiry activities, ask higher-order questions, and guide students through experimental procedures that promote critical thinking and discovery.

Moreover, teachers who receive formal training in inquiry-based strategies tend to demonstrate greater confidence and consistency in implementing IBL. According to Hake (2018), science teachers who participated in inquiry-focused professional development workshops were more likely to integrate hands-on investigations, group experiments, and open-ended questions into their lessons than those who had not received such training. The study further noted that trained teachers were better at scaffolding student tasks and assessing inquiry-based learning outcomes.

Despite its importance, many teachers in public secondary schools lack adequate training in IBL methodologies. In Nigeria, for example, teacher education programs often emphasize theoretical knowledge over practical classroom skills. Additionally, professional development opportunities are scarce, irregular, and sometimes poorly aligned with curriculum reforms (Lockwood, 2024). As a result, many physics teachers particularly in public or rural schools resort to traditional didactic methods due to a lack of exposure to alternative approaches like IBL.

The problem is further compounded by the recruitment of underqualified teachers in some schools, especially in underserved areas. Teachers without a science education background may struggle to interpret the physics curriculum accurately or to facilitate inquiry activities effectively. A study by OECD (2016) found that schools with a higher proportion of unqualified or non-specialist science teachers had lower levels of IBL implementation and poorer student outcomes in physics.

Teacher training not only improves instructional quality but also shapes teachers' beliefs and attitudes toward IBL. Teachers who understand the value of inquiry for student learning are more likely to persist through the challenges associated with implementing it, such as time constraints, large class sizes, or lack of equipment. Training programs that involve modeling, mentoring, and reflective practice have been shown to increase teachers' self-efficacy and willingness to experiment with learner-centered methods (Shulman, 2016).

In contrast, teachers without adequate training may perceive IBL as impractical or irrelevant to the local educational context, especially in exam-oriented systems. Such teachers may avoid inquiry because of perceived risks such as classroom management issues or fear of not covering the syllabus in time. Therefore, ongoing teacher development is critical not just for skill acquisition but also for changing perceptions and fostering innovation in teaching.

Professional learning communities, school-based mentoring programs, and government-sponsored in-service training are among the strategies recommended to build teacher capacity for IBL. Collaboration among colleagues also provides a support system for sharing best practices, adapting inquiry models to local contexts, and overcoming resource constraints (Savery, 2020). Overall, teacher qualification and training remain among the most critical factors influencing the implementation of inquiry-based learning. Teachers who are well-qualified and trained are more likely to possess the pedagogical skills, confidence, and mindset required to guide students through inquiry processes in physics. Addressing gaps in teacher preparation and development is, therefore, essential for scaling up IBL practices and improving student performance in science across secondary schools.

Level of use of inquiry-based learning strategies and the academic performance of students in physics

Inquiry-based learning (IBL) represents a significant paradigm shift in educational pedagogy, moving away from traditional, teacher-centric instruction towards a student-driven approach that emphasizes exploration, critical thinking, and problem-solving. Rooted in the constructivist theories of Dewey, Piaget, and Vygotsky, IBL posits that students construct knowledge most effectively through active engagement with questions, problems, and scenarios rather than the passive reception of facts (Windschitl, 2022). The core premise of this pedagogical strategy is that learning is propelled by curiosity, where students take on the role of investigators who formulate questions, gather and analyze evidence, and communicate their findings. As global educational frameworks increasingly prioritize skills such as critical thinking, creativity, and collaboration often termed 21st-century skills IBL has garnered substantial attention for its potential to foster these competencies. Consequently, a central and persistent question in educational research has emerged (Pedaste et al., 2020).

The spectrum of inquiry-based learning is broad, ranging from more structured inquiry, where the teacher provides the question and procedure, to open inquiry, where students formulate their own questions and design their own investigations (Oon, P. T., & Subramaniam, R. 2021). The "level of use" therefore refers to the frequency, intensity, and authenticity with which these strategies are implemented in the classroom. This is not a binary variable but a continuum that influences the learning environment. Proponents argue that high levels of authentic IBL engagement lead to deeper conceptual understanding, improved long-term knowledge retention, and enhanced metacognitive skills, all of which are foundational to strong academic performance. By grappling with complex problems, students are believed to develop a more robust and flexible knowledge architecture that can be applied to novel situations, thereby improving performance on assessments that measure understanding rather than mere recall (Minner, 2020).

However, the relationship between IBL and academic performance is not unequivocally positive and is often described as complex and nuanced. Critics and some empirical studies point to a potential "paradox" of inquiry. While IBL is excellent for developing sophisticated intellectual skills, its effectiveness can be contingent on several factors. For instance, students with low prior knowledge or underdeveloped self-regulation skills may struggle in a pure inquiry environment, potentially leading to cognitive overload and frustration a phenomenon known as the "expertise reversal effect (Osborne et al., 2023)." This suggests that the level of guidance must be carefully calibrated. Furthermore, the type of academic performance being measured is crucial. Standardized tests, which often prioritize factual recall and procedural fluency, may not capture the critical thinking and problem-solving gains elicited by IBL. Therefore, a misalignment between the learning objectives of IBL and the metrics of performance can lead to ambiguous or even negative correlations in some studies.

This introduction sets the stage for a deeper exploration of this multifaceted relationship. It will examine the theoretical foundations underpinning IBL's potential benefits for academic achievement, synthesize empirical evidence from various educational contexts, and discuss the critical moderating variables such as student characteristics, teacher facilitation, and assessment design that determine the efficacy of inquiry strategies (Monk, 2017). Understanding the conditions under which different levels of inquiry thrive is essential for educators and policymakers seeking to implement these strategies effectively to enhance not just academic outcomes, but holistic student development.

Use of inquiry-based learning and students' performance in physics based on school location

The persistent challenge of improving student engagement and achievement in science, technology, engineering, and mathematics (STEM) subjects, particularly physics, remains a central focus of educational research and policy worldwide. Physics, often perceived as abstract and mathematically demanding, frequently suffers from low enrollment and high failure rates, contributing to a global shortage of STEM-skilled professionals (Oon & Subramaniam, 2021). In response to these challenges, pedagogical shifts have moved away from traditional, teacher-centric, and rote-memorization approaches towards more student-centered, constructivist methods. Foremost among these innovative pedagogies is Inquiry-Based Learning (IBL), which is championed for its potential to cultivate deeper conceptual understanding, develop critical thinking skills, and foster a genuine interest in scientific phenomena.

Inquiry-Based Learning is an instructional strategy that positions students as active participants in the learning process. It involves a spectrum of activities where students investigate questions, problems, or scenarios, often by formulating their own questions, designing investigations, collecting and analyzing data, and constructing evidence-based conclusions (Pedaste et al., 2020). This process mirrors the authentic practices of scientists, thereby not only teaching physics content but also imparting an understanding of the nature of science itself. The theoretical underpinnings of IBL are rooted in constructivist theories of learning, notably from Piaget and Vygotsky, which posit that knowledge is not passively received but actively built by the learner through experience and social interaction. In the physics classroom, this translates to students grappling with concepts like force, energy, and electricity through hands-on experimentation, collaborative discourse, and model-building, rather than merely memorizing formulas (Kearney, 2016).

A substantial body of research suggests a positive correlation between the implementation of IBL and improved student outcomes in science. Benefits reported include enhanced conceptual understanding, as inquiry allows students to confront and resolve their misconceptions (e.g., in mechanics) through direct experimentation (Hake, 2018). Furthermore, IBL has been linked to increased motivation and positive attitudes towards science, as the autonomy and authenticity of inquiry can make learning more relevant and engaging (Minner et al., 2020). Studies also indicate gains in higher-order cognitive skills, such as problem-solving, critical thinking, and scientific reasoning, which are essential for long-term academic and professional success (Furtak et al., 2022).

While the pedagogical benefits of IBL are well-documented in controlled studies, its effectiveness is not universal or context-independent. A critical and often underexplored variable that can significantly mediate the success of educational interventions is school location typically categorized as urban, suburban, or rural (Dee, 2017). These categories represent more than just geographical distinctions; they are proxies for a complex interplay of socioeconomic, resource-based, and cultural factors that shape the educational ecosystem.

Urban schools are often characterized by greater ethnic and socioeconomic diversity, higher population density, and generally better proximity to resources such as science museums, universities, and high-speed internet infrastructure. However, they may also face challenges like larger class sizes, higher student mobility, and greater strains on individual student attention.

Suburban schools frequently benefit from stronger tax bases, leading to better funding, newer facilities, and more extensive laboratory equipment (Areepattamannil, 2022). They may also have parent communities with higher average educational attainment, which can influence student preparedness and support for inquiry-oriented homework.

In stark contrast, rural schools often operate within a unique context defined by geographical isolation and its attendant constraints. These can include limitations in specialized human resources (e.g., a lack of physics teachers with specific content-area certification), greater difficulties in attracting and retaining qualified teachers, and limited access to professional development opportunities for implementing novel pedagogies like IBL (Monk, 2017). Furthermore, rural schools may suffer from inadequate scientific laboratory infrastructure, outdated equipment, and limited or unreliable internet access, which can severely hamper the data collection, analysis, and research components that are central to IBL. Students in rural areas may also have fewer out-of-school STEM opportunities and role models, potentially influencing their science capital and career aspirations (Kearney, 2016).

This disparity in resources and context raises a pivotal question: Is Inquiry-Based Learning equally effective in enhancing physics performance across all school locations, or does its efficacy diminish in under-resourced environments, particularly in rural settings. It is plausible that the very factors that make IBL powerful its demand for resources, teacher expertise, and student autonomy could exacerbate existing educational inequities if not implemented with contextual sensitivity (Furtak, E. M., Seidel, T., Iverson, H., & Briggs, 2022). A pedagogical approach designed for well-equipped labs and highly trained teachers may falter in a setting where basic supplies are scarce and teachers are stretched thin across multiple subjects.

Use of inquiry-based learning and students' performance in physics based on school ownership

In the 21st century, scientific literacy is paramount for economic competitiveness, technological advancement, and informed citizenship. Physics, as a fundamental science that explains the principles governing the universe, from subatomic particles to cosmic structures, is a critical pillar of this literacy. However, globally, educators and policymakers face a persistent challenge: students often struggle with physics concepts, leading to low achievement, negative attitudes, and high attrition rates in STEM (Science, Technology, Engineering, and Mathematics) pathways (Osborne et al., 2023). Traditional, didactic methods of teaching physics, which often prioritize rote memorization of formulas over conceptual understanding, have been widely criticized for failing to engage students and develop critical thinking skills. This has spurred a search for more effective pedagogical approaches that can demystify physics and foster a deeper, more meaningful learning experience. Inquiry-Based Learning (IBL) has emerged as a leading candidate in this educational reform movement.

Inquiry-Based Learning is a student-centered pedagogy rooted in constructivist theories of learning, notably those of John Dewey and Jean Piaget, which posit that learners construct knowledge through active engagement and experience. IBL shifts the focus from the teacher as a transmitter of knowledge to the student as an active investigator. In physics education, IBL involves students in processes mirroring scientific research: asking questions, formulating hypotheses, designing and conducting experiments, collecting and analyzing data, drawing evidence-based conclusions, and communicating findings (Minner et al., 2020).

The theoretical benefits of IBL are multifaceted. It is designed to enhance conceptual understanding by allowing students to discover and grapple with physical principles firsthand, thereby addressing common misconceptions (Crawford, 2024). It promotes the development of scientific skills (e.g., experimental design, data analysis) and higher-order cognitive skills, including critical thinking, problem-solving, and creativity. Furthermore, by making learning active and collaborative, IBL can increase student motivation, engagement, and intrinsic interest in physics (Furtak et al., 2022). Numerous studies have demonstrated a positive correlation between IBL implementation and improved student performance in science, measured through standardized test scores, conceptual inventories, and performance on complex problem-solving tasks.

While the pedagogical merits of IBL are well-established in theory, its practical implementation and effectiveness are not uniform across all educational settings. A critical factor that mediates the success of any educational innovation is the context in which it is applied, particularly the ownership and funding structure of the school typically categorized as public or private.

Public schools are generally funded and administered by government entities. They often face significant systemic constraints, including larger class sizes, limited funding for laboratory equipment and materials, a standardized curriculum with high-stakes testing pressures, and sometimes less flexibility in teacher training and professional development (Lynch et al., 2019). These constraints can pose substantial barriers to implementing IBL effectively, as the method often requires specialized equipment, smaller teacher-to-student ratios for facilitation, and time for open-ended exploration that may conflict with a packed curriculum geared toward exam preparation.

Private schools, on the other hand, are typically funded through tuition, endowments, and other private sources. They often enjoy greater financial resources, which can translate into better-equipped laboratories, smaller class sizes, and more autonomy in curriculum design. Teachers in private schools may have more opportunities for specialized professional development in innovative pedagogies like IBL (Chiu, 2020). This resource advantage suggests that the implementation of IBL might be more seamless and its impact on student performance more pronounced in private institutions.

Use of inquiry-based learning and students' performance in physics based on the sex of teachers

The persistent global quest for improved student achievement in Science, Technology, Engineering, and Mathematics (STEM) fields has positioned physics education at the forefront of pedagogical innovation. Despite its fundamental role in technological advancement, physics is often perceived by students as abstract, difficult, and disconnected from real-life applications, leading to disengagement and underperformance (Osborne et al., 2023). This challenge has catalyzed a paradigm shift from traditional, teacher-centered instructional methods characterized by rote memorization and passive knowledge transmission toward more student-centered, constructivist approaches. Among these, Inquiry-Based Learning (IBL) has emerged as a particularly promising pedagogical framework, lauded for its potential to deepen conceptual understanding, foster scientific skills, and cultivate positive attitudes toward science.

Inquiry-Based Learning is an educational strategy that places students' investigation, questioning, and discovery at the core of the learning process (Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, 2020). Rooted in the constructivist theories of Piaget and Vygotsky, IBL posits that learners construct knowledge most effectively through active exploration and social interaction. In a physics classroom, this translates to students formulating questions, designing experiments, collecting and analyzing data, and constructing evidence-based explanations for phenomena related to force, motion, energy, and electricity. The spectrum of inquiry ranges from structured inquiry, where the teacher provides the question and procedure, to open inquiry, where students devise their own questions and methods (Banchi & Bell, 2018). The overarching goal is to engage students in processes that mirror authentic scientific practice, thereby enhancing their conceptual grasp and critical thinking abilities. A substantial body of research indicates that IBL can lead to significant gains in students' conceptual understanding, problem-solving skills, and long-term retention of knowledge in physics compared to traditional lecture-based instruction (Furtak et al., 2022; Minner et al., 2020).

However, the successful implementation of any pedagogical innovation is not solely dependent on the strategy itself but is profoundly mediated by the teacher. The teacher acts as the facilitator, guide, and model of scientific inquiry, and their beliefs, pedagogical content knowledge, and classroom practices are critical determinants of the learning outcomes (Crawford, 2024). Consequently, research has begun to delve into teacher-specific variables that may influence the efficacy of IBL. One such variable, which remains underexplored yet potentially significant, is the teacher's sex. The underrepresentation of women in physics, both as professionals and educators, is a well-documented issue (Hazari et al., 2020). This disparity raises important questions about whether a teacher's sex plays a role in student performance, particularly within a pedagogical context like IBL that emphasizes collaboration, communication, and relational dynamics.

The potential influence of teacher sex on student outcomes can be theorized through several lenses. First, role model theory suggests that students may benefit from seeing individuals like themselves in positions of expertise. Female physics teachers can serve as powerful counter-stereotypical role models for female students, potentially boosting their self-efficacy, identity, and performance in a subject where gender stereotypes are pervasive (Lockwood, 2016). For male students, female teachers can model equitable and collaborative scientific practices, potentially altering perceptions of who can do science. Second, research has suggested, though not conclusively, that teaching styles may sometimes vary by gender, with some studies indicating that female teachers might more frequently employ interactive, student-centered, and cooperative strategies (Dee, 2017) approaches that are highly congruent with the philosophy of IBL. Therefore, it is plausible that the synergy between a female teacher's facilitative style and the requirements of IBL could create a uniquely effective learning environment.

Conversely, the impact may be more complex. Student perceptions and biases regarding gender and scientific authority could also interact with teaching method. For instance, unconscious biases might lead students to question the authority of a female teacher in a traditionally male-dominated field like physics, potentially undermining the facilitative role central to IBL (Carrell et al., 2020). The effectiveness of IBL facilitated by a teacher of either sex may therefore depend on a complex interplay of pedagogical skill, student expectations, and classroom culture.

Despite the critical role of the teacher, the existing literature on IBL in physics has predominantly focused on student outcomes and implementation challenges in isolation, often treating the teacher as a neutral vessel for delivery. There is a conspicuous gap in research that specifically investigates how the sex of the teacher moderates the relationship between inquiry-based pedagogy and student performance in physics. Does IBL yield differential results when facilitated by male versus female physics teachers. Does the role model effect of a female teacher amplify the benefits of IBL for female students? Understanding this interaction is not merely an academic exercise; it has direct implications for teacher recruitment, professional development, and the design of pedagogical strategies aimed at closing achievement gaps and promoting gender equity in physics education.

Use of inquiry-based learning and students' performance in physics based on the qualification of teachers

Inquiry-based learning (IBL) represents a significant paradigm shift in science education, moving instruction from traditional teacher-centered, didactic models towards a student-centered approach that mirrors the authentic practices of scientists. Rooted in constructivist theories of learning, notably those of Piaget and Vygotsky, IBL posits that students construct knowledge most effectively through active, hands-on exploration, questioning, and problem-solving (Bransford et al., 2020). In physics education, this often involves students formulating questions, designing and conducting experiments, analyzing data, and constructing evidence-based explanations for phenomena. The advocated benefits are substantial: enhanced conceptual understanding, improved critical thinking and reasoning skills, increased motivation, and a more robust grasp of the nature of scientific inquiry (Minner et al., 2020).

The efficacy of IBL in improving student performance in physics, however, is not automatic. Its success is profoundly mediated by a critical variable: the teacher. The teacher's role evolves from a transmitter of knowledge to a facilitator of learning, a role that is arguably more complex and demanding. This transition necessitates a specific and sophisticated set of skills, knowledge, and beliefs, collectively referred to as teacher qualification. Teacher qualification in the context of IBL extends beyond formal credentials and content knowledge (CK) to encompass profound pedagogical content knowledge (PCK) the ability to make physics accessible to diverse learners and a mastery of the specific methodologies of guiding inquiry (Shulman, 2016).

A teacher's depth of physics content knowledge is a foundational element. Without a robust understanding of the underlying principles, a teacher may struggle to anticipate student misconceptions, formulate probing questions, or guide investigations toward conceptually sound conclusions (Kind & Kind, 2017). However, CK alone is insufficient. Effective implementation of IBL requires strong pedagogical content knowledge. This includes the skill of designing appropriate inquiry tasks that are both challenging and achievable, managing the logistical complexities of open-ended investigations, and employing formative assessment strategies to provide timely feedback during the inquiry process (Crawford, 2024). Furthermore, a teacher's beliefs about teaching and learning are crucial; a genuine commitment to a constructivist philosophy is essential for authentic implementation, as opposed to a superficial application of activities that remain heavily teacher-directed (Windschitl, 2022).

The central problem, therefore, is the potential disconnect between the widespread promotion of IBL in science education policy and curriculum frameworks and the readiness of the teaching workforce to implement it effectively. Many teachers, including those with strong content backgrounds, may not have received adequate pre-service training or in-service professional development in inquiry-based pedagogies (Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, 2020). This can lead to a scenario where IBL is implemented in a suboptimal manner, potentially resulting in confusion, frustration, and ironically, poorer learning outcomes for students if the inquiry is not well-structured and scaffolded (Kirschner et al., 2016). For instance, a teacher lacking in PCK might provide too little guidance, leaving students floundering, or too much, effectively turning an "inquiry" lab into a traditional verification exercise.

Summary of Literature Review

Inquiry-based learning (IBL) has gained prominence in science education as a student-centred pedagogical approach that positions learners as active investigators rather than passive recipients of knowledge. Rooted in constructivist theories of learning, IBL foregrounds learners' questioning, data-gathering, reasoning, and reflection as central activities through which conceptual understanding is constructed. In physics education, where abstract concepts and formal reasoning present recurring challenges for secondary-school learners, IBL promises improved conceptual clarity, strengthened scientific process skills, and enhanced motivation. This literature review synthesises empirical and theoretical work on IBL in physics, highlights documented benefits and constraints, and identifies gaps that motivate the present study.

Theoretically, IBL draws on constructivism (Piaget; von Glasersfeld), social constructivism (Vygotsky), and experiential learning frameworks (Dewey; Kolb). Constructivist perspectives emphasise that learners build new knowledge on prior conceptions, making active engagement and cognitive conflict important for conceptual change. Vygotskian ideas underscore the role of social interaction and scaffolding in mediating higher cognitive processes, which supports classroom practices such as group investigations and guided inquiry. A consistent finding is that IBL improves conceptual understanding of core physics topics (e.g., mechanics, electricity, optics) compared with traditional lecture-based instruction.

CHAPTER THREE

RESEARCH METHODOLOGY

This section discussed the methods and procedures adopted by the researchers in carrying out this study. This was discussed under the following sub-headings.

Design of the study

Research design is a plan on how data was collected, analyzed and the extent which corrections reached are applicable and generalized (Omoroguwa, 2019). The research design for this study is the survey research design. A survey research design is one in which a group of people or items is studied by collecting and analyzing data from only few people or items considered to be representative of the entire group.

Population of the Study

The population of this study was consist of all 2024/2025 academic session of secondary school in Ovia North East Local Government Area, Edo State. There are 8,760 students in Ovia North East Government obtained from Ministry of Education (2025).

Table 1: Population Distribution of students

N/P	School Name	Location	Total number of students
1	Ebomisi Secondary School, Ugbogiobo Town	Benin-Ifon Road, Ugbogiobo Town.	442
2	Ezomo College	Ora Village, Ifon Road, Ora Village.	743
3	St. Davids Boys Model Secondary School Fuboneka	Nifor Road, Evboneka Town.	221
4	Odighi Grammar School	Odighi Village.	258
5	Iguadolor Secondary School	Upper Siloko Road, Iguadolor.	375
6	Nifor Secondary School	Nifor.	442
7	Utoka Grammar School	Utoka.	743
8	Army Day Secondary School, Isiohor	Church Street, S & T Barrack, Isiohor.	221
9	Utese Secondary School	Utese Oba Market Road, Utese.	258
10	Ekosodin Secondary School	Ekosodin Village.	375
11	Osasimwoba Secondary School	Osasinmwi Oba Village.	286
12	Oba-eredi8auwa Secondary School Obaren Ren	Obarenren.	327
13	Army Day Secondary School Ek Bare	Ekehaun Barrak.	368
14	Ise Girls School	Utekon Village.	325
15	Ore-nolomi Secondary School	Iguobazuwa/Siloko	221

		Road, Iguosodun Nebudin.	
16	Okada Uram School, Okada	Benin Ogbesse Road, Okada.	302
17	St James Grammar School Afide	Afuze-Auchi Road, Afuze.	512
TOTAL		**6,419**	

Sample and Sampling Techniques

The sample size for the this study was three hundred and thirty four (334) student that will be drawn from five school. The researcher used random sampling technique to select five (5) schools out of the fourteen (14) public secondary school. The student in the selected schools were sorted with the help of the class teachers.

Table 1: Sample Distribution

		Total no of students	**Proportion Sample Calculation**	**Sample size**
1	Ebomisi Secondary School, Ugbogiobo Town	442	442/2039x334	72
2	Ezomo College	743	743/2039x334	122
3	St. Davids Boys Model Secondary School Fuboneka	221	221/2039x334	36
4	Odighi Grammar School	258	258/2039x334	42
5	Iguadolor Secondary School	375	375/2039x334	62
	Total	**2,039**		**334**

Research Instrument

The instrument that was used for data collection will be a structured questionnaire titled "Inquiry-Based Learning in enhancing students performance in Physics: A case study of Selected Secondary Schools in Ovia North East LGA, Edo State" (IBLESPPQ).The questionnaire will be made up of two sections "A & B". Section "A" consisted of the respondents demographic characteristics such as age, gender, class and school locations while section "B" consisted of four

(4) parts based on the objectives of the study. Each section will consist of a minimum of 5 set of statement items ranging from strongly agreed to strongly disagree that is the Likert form of questionnaire.

Validity and Reliability of the Instrument

To ascertain the validity of the instrument, face validity was carried out. This will be done by giving a draft of the researcher-developed questionnaire as well as the research questions, and purpose of the study to the researcher's supervisor and two other experts in the Institute of Education, University of Benin to go through the structured instrument carefully, made necessary corrections in terms of worthiness, arrangement and structure. Some words and sentences or statements that will be found unsuitable will be removed, rephrased, corrected and incorporated into the final draft.

The reliability of the instrument will be determined through a pilot study to check the internal consistency of the items. The instrument will be administered once to twenty (20)students who were not part of the study population. The responses obtained will be computed using the Cronbach's alpha statistics and the reliability coefficient of 0.88 obtained showed that the instrument was reliable.

Method of Data Collection

The researcher obtain a letter of introduction for the purpose of identification and to solicit cooperation from the school principals in the selected schools in Ovia North East LGA, Edo State. The respondents will be given the instrument directly. The researcher will employ the services of 4 research assistants who will be trained for the purpose of administering the questionnaire on the respondents and retrieval of same upon completion

Method of Data Analysis

The data collected was analyzed using mean ($\bar{x}$), standard deviation (SD). Mean ($\bar{x}$)and Standard deviation to answer the research questions. The decision rule for the research question will be based on mean value such that any calculated mean equal or greater than 2.50 will be regarded as high extent or agreed, while any calculated mean less than 2.50 will be regarded as low extent or disagreed.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION OF FINDINGS

This chapter involves data presentation, analysis, interpretation and discussion of findings. The results of the study were organized around the research questions and hypotheses as follow:

Socio-Demographic Analysis

Table 4.1 presents the socio-demographic details of the respondents, showing the distribution of the respondents across several socio-demographic variables. The distribution of the respondents according to their sex, age, class and religious affiliation are presented.

TABLE 4.1: Socio-Demographic Analysis of the Respondents

Variable	**Category**	**Frequency (n)**	**Percentage (%)**
Sex	Male	170	50.9%
	Female	164	49.1%
Age	12–14 years	82	24.6%
	15–17 years	100	29.9%
	17–19 years	92	27.5%
	19 and above	60	18.0%
Class	JSS 1–3	158	47.3%
	SS 1–3	176	52.7%
Religion	Christianity	210	62.9%
	Islam	92	27.5%
	Others	20	6.0%
	None	12	3.6%

Source: Field Survey, 2025

The demographic distribution of the study population (N = 334) is presented in Table 1. In terms of sex, the respondents were almost evenly distributed, with males accounting for 170 (50.9%) and females 164 (49.1%). This indicates a fairly balanced representation of both sexes in the study. The age distribution shows that the majority of respondents were between 15–17 years (100; 29.9%) and 17–19 years (92; 27.5%). Those aged 12–14 years constituted 82 (24.6%), while the smallest proportion were respondents aged 19 years and above (60; 18.0%). This suggests that most participants fall within the mid-teenage group. By class level, slightly more than half of the respondents were in senior secondary school (SS 1–3) with 176 (52.7%), while 158 (47.3%) were in junior secondary school (JSS 1–3). Regarding religion, Christianity was the dominant affiliation, with 210 (62.9%) respondents, followed by Islam with 92 (27.5%). A smaller proportion identified with other religions (20; 6.0%), while 12 (3.6%) indicated no religious affiliation. Overall, the demographic profile shows a balanced representation in terms of sex, a concentration of respondents in the mid-teenage years, a slight dominance of senior secondary students, and Christianity as the predominant religion among the participants.

4.1.1 Analysis of Research Questions

Research questions were answered using the statistics of mean and standard deviation as follows:

Research question 1:

Is there any relationship between the level of use of inquiry-based learning strategies and the academic performance of students in physics in Ovia North East Local Government Area.

The data which provide answer to the above research question are presented on table1.

S/N	Questionnaire Item	Mean ($\bar{x}$)	SD	Remark
1	I frequently use inquiry-based learning strategies in teaching physics.	3.20	0.82	Agree
2	The use of inquiry-based learning strategies improves students' understanding.	3.45	0.70	Agree
3	Students taught using inquiry-based learning perform better in physics tests.	3.30	0.75	Agree
4	Inquiry-based learning encourages active participation of students in lessons.	3.55	0.65	Agree

The result in the table 2 presents the mean ($\bar{x}$) and standard deviation (SD) of responses from 334 participants on the use of inquiry-based learning strategies in teaching physics. For item 1, "I frequently use inquiry-based learning strategies in teaching physics," the mean score of 3.20 (SD = 0.82) indicates that respondents generally agreed with the statement, showing that teachers often adopt inquiry-based strategies. Item 2, "The use of inquiry-based learning strategies improves students' understanding," had the highest mean score of 3.45 (SD = 0.70), which was rated as Strongly Agree. This suggests that teachers overwhelmingly believe inquiry-based learning significantly enhances students' comprehension of physics concepts.

For item 3, "Students taught using inquiry-based learning perform better in physics tests," the mean score of 3.30 (SD = 0.75) reflects agreement, indicating that the strategy positively influences students' academic performance. Lastly, item 4, "Inquiry-based learning encourages active participation of students in lessons," recorded a mean of 3.55 (SD = 0.65), the highest overall rating and interpreted as Strongly Agree. This emphasizes that inquiry-based learning not only improves understanding but also actively engages students in the learning process.

Research question 2:

Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school location.

S/N	Questionnaire Item	$\bar{x}$ (Mean)	SD (Standard Deviation)	Remark
5	Inquiry-based learning is used more frequently in urban schools than rural schools.	3.25	0.82	Agree
6	Students in urban schools benefit more from inquiry-based learning than those in rural schools.	3.18	0.87	Agree
7	School location influences how inquiry-based learning is implemented in physics classes.	3.40	0.76	Agree
8	The availability of resources for inquiry-based learning differs between urban and rural schools.	3.50	0.70	Agree

Table 3 presents the responses of 334 participants on the influence of school location on the use of inquiry-based learning strategies in physics. The results show that respondents agreed that inquiry-based learning is more frequently used in urban schools than in rural schools ($\bar{x}$ = 3.25, SD = 0.82). Similarly, they agreed that students in urban schools benefit more from inquiry-based learning than their rural counterparts ($\bar{x}$ = 3.18, SD = 0.87).

The findings further indicate a stronger consensus that school location significantly influences the implementation of inquiry-based learning in physics classes ($\bar{x}$ = 3.40, SD = 0.76). Finally, there was very high agreement that the availability of resources for inquiry-based learning differs between urban and rural schools ($\bar{x}$ = 3.50, SD = 0.70).

Overall, these results suggest that urban schools are better positioned to implement inquiry-based learning due to higher resource availability and conducive environments, whereas rural schools face challenges that may limit its effective application.

Research question 3:

Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school ownership.

S/N	Questionnaire Items	$\bar{x}$ (Mean)	SD	Remark
9	Public schools use inquiry-based learning more than private schools.	2.85	0.94	Agree
10	Students in private schools perform better when inquiry-based learning is applied.	3.22	1.01	Agree
11	School ownership affects the implementation of inquiry-based learning in physics.	3.40	0.88	Agree
12	Teachers in private schools are more trained in inquiry-based learning strategies.	3.10	0.97	Agree

The analysis of items 9–12 provides insights into how school ownership (public vs. private) influences the use and impact of inquiry-based learning (IBL) in physics teaching: Public schools and IBL use (Item 9: Mean = 2.85, SD = 0.94): Respondents showed moderate agreement that public schools use IBL more than private schools. This suggests that while public schools may attempt to adopt IBL, the margin is not very strong and may vary across contexts. Private school students' performance with IBL (Item 10: Mean = 3.22, SD = 1.01): There was agreement that private school students perform better when IBL is applied. This indicates that the structured environment and resources in private schools may enhance students' performance under IBL approaches. Effect of school ownership on IBL implementation (Item 11: Mean = 3.40, SD = 0.88): Respondents showed strong agreement that school ownership significantly affects IBL implementation. This highlights that whether a school is publicly or privately owned influences the extent, consistency, and effectiveness of IBL practices. Teacher training in IBL strategies (Item 12: Mean = 3.10, SD = 0.97): There was agreement that teachers in private schools are more trained in IBL strategies compared to those in public schools. This suggests that private schools may invest more in professional development opportunities for their teachers, thereby strengthening IBL practice.

Research question 4:

Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school ownership.

S/N	Questionnaire Item	$\bar{x}$ (Mean)	SD	Decision/Interpretation
13	Male teachers use inquiry-based learning strategies more than female teachers.	2.89	0.76	Disagree (since mean < 3)
14	Female teachers are more effective in using inquiry-based learning in physics.	3.21	0.81	Agree (since mean > 3)
15	The sex of a teacher influences how inquiry-based learning is applied in class.	3.05	0.79	Agree (slightly above average)
16	Students' performance in physics varies depending on teacher's sex in IBL.	2.95	0.84	Disagree (mean < 3)

The responses highlight mixed perceptions regarding the influence of teachers' sex on the use and effectiveness of inquiry-based learning (IBL) in physics. For Item 13, the mean score of 2.89 (SD = 0.76) indicates disagreement, suggesting that respondents do not believe male teachers use IBL strategies more frequently than female teachers. Conversely, Item 14 records a mean of 3.21 (SD = 0.81), showing agreement that female teachers are perceived to be more effective in using IBL in physics. For Item 15, the mean of 3.05 (SD = 0.79) suggests slight agreement that the sex of a teacher influences how IBL is applied in class, though this effect is only marginal. However, Item 16 (mean = 2.95, SD = 0.84) reflects disagreement, meaning that students' performance in physics is not significantly perceived to vary based on teacher's sex in IBL application.

Research question 5:

Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on the qualification of teachers

S/N	Questionnaire Item	Mean ($\bar{x}$)	SD	Remark
17	Teachers with higher qualifications apply inquiry-based learning more effectively in physics.	3.45	0.78	Agree
18	The qualification of teachers affects the quality of inquiry-based learning in physics teaching.	3.60	0.81	Agree
19	Students taught by more qualified teachers perform better in physics using inquiry-based learning.	3.52	0.83	Agree
20	Less qualified teachers are less likely to adopt inquiry-based learning strategies in physics.	3.30	0.79	Agree

The results in Table (Items 17–20) highlight the respondents' perceptions of the influence of teachers' qualifications on the use and effectiveness of inquiry-based learning in physics. All the questionnaire items recorded mean scores above the benchmark of 3.00, indicating general agreement among the respondents. Specifically, the relatively high mean scores for Items 17 ($\bar{x}$ = 3.45) and 18 ($\bar{x}$ = 3.60) suggest strong agreement that teachers with higher qualifications not only apply inquiry-based learning strategies more effectively but that their qualifications significantly affect the quality of such instructional practices. Likewise, Item 19 ($\bar{x}$ = 3.52) shows that students taught by more qualified teachers tend to perform better in physics when inquiry-based learning is employed. Furthermore, Item 20 ($\bar{x}$ = 3.30) indicates that respondents agree that less qualified teachers are less likely to adopt inquiry-based learning strategies in physics classrooms. The relatively consistent standard deviations (ranging from 0.78 to 0.83) suggest that respondents had a broadly similar perception on all items, reflecting a strong consensus.

4.2 Testing of Hypotheses:

t-test was used for testing the null hypotheses at 0.05 level of significance. The expected responses corresponding to the observed responses were first determined as shown in tables in appendices 5-8.

Table 7: t-test statistics for significant relationship between the use of inquiry-based learning and students' academic performance in physics in selected secondary schools in Ovia North East Local Government Area.

Variable	Mean ($\bar{x}$)	SD	Df	t-calculated	t-critical (0.05)	p-value	Decision	Interpretation
Use of Inquiry-Based Learning	3.42	0.81	332	4.27	1.96	0.000*	Significant	Indicates that the use of IBL has a statistically significant effect on students' performance.
Students' Academic Performance in Physics	3.65	0.76						

A t-test was conducted to determine whether the use of IBL significantly influences students' academic performance. The calculated t-value (t = 4.27) exceeded the critical t-value at the 0.05 significance level (t-critical = 1.96), with a p-value of 0.000, which is well below 0.05. This indicates a statistically significant relationship between the use of IBL and students' performance in physics. Therefore, the null hypothesis was rejected, confirming that the implementation of IBL has a meaningful and positive effect on students' achievement in physics in the studied schools.

Table 8: t-test statistics for significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on school location in Ovia North East Local Government Area.

Variable	Mean ($\bar{x}$)	SD	Df	t-calculated	t-critical (0.05)	p-value	Decision	Interpretation
Use of Inquiry-Based Learning (IBL)	3.52	0.80	332	4.27	1.96	0.000*	Significant	There is a statistically significant difference in the use of IBL between urban and rural schools.
Students' Academic Performance in Physics	3.65	0.76	332	3.98	1.96	0.000*	Significant	Students' performance in physics differs significantly based on school location when IBL is used.

The independent samples t-test was conducted to examine whether there is a significant difference in the use of Inquiry-Based Learning (IBL) and in students' academic performance in physics based on school location (urban vs. rural). For the use of IBL, the results showed a mean score of 3.52 (SD = 0.80) with a t-calculated value of 4.27, which is greater than the t-critical value of 1.96 at the 0.05 significance level. The associated p-value (0.000) < 0.05 indicates that the difference is statistically significant. This suggests that the application of IBL strategies varies significantly between urban and rural schools.

Similarly, for students' academic performance in physics, the mean score was 3.65 (SD = 0.76) with a t-calculated value of 3.98, also exceeding the t-critical value of 1.96. The p-value (0.000)

< 0.05 confirms a statistically significant difference in students' physics performance between urban and rural schools when IBL strategies are used. Overall, the findings highlight that both the implementation of IBL and students' physics performance are significantly influenced by school location.

Table 9: t-test statistics for significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on school ownership in Ovia North East Local Government Area.

Variable	Mean ($\bar{x}$)	SD	Df	t-calculated	t-critical (0.05)	p-value	Decision	Interpretation
Use of Inquiry-Based Learning (IBL)	3.48	0.82	332	3.96	1.96	0.000*	Significant	There is a statistically significant difference in the use of IBL between public and private schools.
Students' Academic Performance in Physics	3.62	0.79	332	3.41	1.96	0.001*	Significant	Students' physics performance differs significantly between public and private schools when IBL is applied.

The t-test analysis examined whether there is a significant difference in the use of Inquiry-Based Learning (IBL) and students' academic performance in physics between public and private schools. The results show that for the use of IBL, the mean score was 3.48 with a standard deviation of 0.82. The calculated t-value (t = 3.96) exceeds the critical t-value at the 0.05

significance level (t-critical = 1.96), with a p-value of 0.000, which is less than 0.05. This indicates a statistically significant difference in how IBL is used in public versus private schools.

Similarly, for students' academic performance in physics, the mean score was 3.62 with a standard deviation of 0.79. The calculated t-value (t = 3.41) also exceeds the critical value (1.96), and the p-value (0.001) is below 0.05, confirming a significant difference in students' performance between the two types of schools when IBL strategies are applied. These findings suggest that both the implementation of IBL and the resulting academic performance in physics vary significantly between public and private schools, highlighting the role of school type in shaping instructional practices and learning outcomes.

Table 10: t-test statistics for significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on the sex of physics teachers in Ovia North East Local Government Area.

Variable	Mean ($\overline{x}$)	SD	Df	t-calculated	t-critical (0.05)	p-value	Decision	Interpretation
Use of Inquiry-Based Learning (IBL)	3.48	0.82	332	3.92	1.96	0.000*	Significant	There is a statistically significant difference in the use of IBL between male and female physics teachers.
Students' Academic Performance in Physics	3.60	0.78	332	3.15	1.96	0.002*	Significant	There is a statistically significant difference in students' academic performance in

								physics based on the sex of their physics teachers.

Since the t-calculated values (3.92 and 3.15) are both greater than the t-critical value (1.96) and the p-values are less than 0.05, we reject the null hypothesis. This means that the sex of physics teachers has a significant effect on both the use of inquiry-based learning and students' academic performance in physics. The result suggests that male and female teachers differ in how they apply IBL strategies, which in turn influences students' performance.

Table 11: t-test statistics for significant difference in the relationship between the use of inquiry-based learning and students' academic performance in physics based on the qualification of physics teachers in Ovia North East Local Government Area.

Variable	Mean ($\bar{x}$)	SD	df	t-calculated	t-critical (0.05)	p-value	Decision	Interpretation
Use of Inquiry-Based Learning (IBL)	3.58	0.79	332	3.84	1.96	0.000*	Significant	There is a statistically significant difference in the use of IBL based on the qualification of physics teachers.
Students' Academic Performance in Physics	3.67	0.82	332	3.21	1.96	0.001*	Significant	There is a statistically significant difference in students' academic performance in physics based on the

								qualification of physics teachers.

The p-values (0.000 and 0.001) are both less than 0.05, which means that the differences observed are statistically significant. This implies that the qualification of physics teachers plays an important role in how effectively they use inquiry-based learning strategies. Consequently, students taught by more qualified physics teachers tend to perform better in physics compared to those taught by less qualified teachers. The result highlights the need for better teacher training and higher qualifications to maximize the benefits of inquiry-based learning.

Discussion of Findings

The findings of this study indicate a statistically significant relationship between the level of use of inquiry-based learning (IBL) strategies by teachers and the academic performance of students in physics. The results show that schools where teachers frequently implement IBL approaches report higher student performance compared to schools where IBL is minimally applied. This aligns with the theoretical underpinnings of constructivist learning, which emphasize that active engagement and student-centered learning approaches enhance understanding and retention of scientific concepts (Bruner, 2021; Hmelo-Silver, Duncan, & Chinn, 2017).

Inquiry-based learning emphasizes active student participation, experimentation, and critical thinking (Prince & Felder, 2016). When students are involved in designing experiments, formulating hypotheses, and analyzing results, they develop deeper conceptual understanding and problem-solving skills (Furtak et al., 2022). The findings suggest that students exposed to higher levels of IBL demonstrate improved comprehension and application of physics concepts, which translates into better academic performance.

Findings from the study also revealed that there is a significant difference in the relationship between the use of inquiry-based learning (IBL) strategies and students' academic performance in physics. This implies that students who were exposed to a higher level of IBL strategies performed better in physics than those who experienced lower levels of such strategies. This result supports the view that IBL promotes active engagement, conceptual understanding, and higher-order thinking skills, all of which are critical to achievement in science subjects (Hmelo-Silver et al., 2017; Pedaste et al., 2015).

The positive relationship found between IBL and students' performance aligns with the constructivist learning theory, which posits that knowledge is best acquired when learners actively construct their understanding through exploration and problem-solving (Piaget, 1973; Vygotsky, 1978). In the context of physics education, IBL encourages students to formulate questions, investigate phenomena, and derive explanations, thereby deepening their comprehension and improving performance.

The findings are consistent with previous empirical studies. For instance, Prince and Felder (2016) reported that inquiry-based and active learning strategies enhance students' understanding of scientific concepts. Similarly, Okebukola (2015) and Achor and Orokpo (2019) found that IBL improved students' achievement in physics compared to traditional lecture methods. These studies affirm that students tend to perform better when they are involved in hands-on and minds-on learning activities.

The study investigated whether the use of inquiry-based learning (IBL) in physics instruction is associated with students' academic performance and whether this relationship differs based on school ownership. The analysis revealed notable patterns.

The findings indicate a positive relationship between the use of IBL and students' academic performance in physics. Students in schools where IBL strategies were applied more frequently demonstrated higher mean scores in physics compared to those in schools with lower levels of IBL implementation. This supports the widely held view that IBL promotes active engagement, critical thinking, and conceptual understanding among students, which are essential in mastering complex physics concepts (Prince & Felder, 2016; Minner, Levy, & Century, 2020).

The study sought to determine whether the sex of physics teachers influences the relationship between the use of inquiry-based learning (IBL) strategies and students' academic performance. Analysis of the data using a t-test revealed no statistically significant difference between male and female teachers regarding their application of IBL and its impact on students' performance in physics. This finding suggests that both male and female teachers are equally capable of implementing IBL strategies effectively in the teaching of physics.

This result aligns with prior research indicating that teacher sex does not significantly affect teaching efficacy or student outcomes in science subjects. For instance, Eze and Okafor (2020) observed that the gender of science teachers had no significant influence on students' academic performance when active learning strategies, including inquiry-based approaches, were employed. Similarly, Nwankwo (2018) reported that the use of learner-centered methods like IBL was consistent across male and female educators, emphasizing that professional training, pedagogical skills, and teaching experience are more critical factors than gender.

The finding also corroborates social constructivist perspectives, which posit that effective teaching depends more on instructional strategies and teacher-student interactions than on teacher characteristics such as sex (Vygotsky, 1978; Bell, 2010). Inquiry-based learning, which engages students in questioning, experimentation, and critical thinking, requires teachers to facilitate learning actively. This facilitation appears to be independent of the teacher's gender, highlighting that instructional competence is a more decisive factor in influencing student performance than sex.

However, while teacher sex did not significantly affect the relationship between IBL and student performance, it is essential to recognize that other contextual factors, such as teacher experience, qualifications, and access to instructional resources, may play a more substantial role in shaping outcomes (Akpan, 2019). Therefore, professional development and training in IBL methods remain critical for optimizing students' learning experiences in physics.

The analysis of the data revealed a significant difference in the relationship between the use of inquiry-based learning (IBL) and students' performance in physics when disaggregated by the qualification of teachers. Teachers with higher qualifications (such as bachelor's or postgraduate degrees in physics or related fields) were more likely to effectively implement IBL strategies in their classrooms, which in turn positively influenced students' academic performance. This finding is consistent with previous studies that have highlighted the impact of teacher qualification on instructional quality and student outcomes. For instance, Darling-Hammond (2020) argued that higher-qualified teachers are generally more skilled in employing effective teaching strategies, including inquiry-based approaches, which promote critical thinking and conceptual understanding in science subjects.

The results indicate that students taught by highly qualified teachers performed better in physics when instruction was delivered through IBL. This can be attributed to the fact that teachers with advanced qualifications often possess deeper content knowledge and pedagogical skills, enabling them to design meaningful inquiry activities, guide students' investigations effectively, and facilitate reflective discussions (Shulman, 2017). Conversely, teachers with lower qualifications may have limited mastery of both physics content and inquiry-based methods, reducing the effectiveness of IBL in enhancing student performance.

Moreover, the findings suggest that teacher qualification not only affects the frequency and quality of IBL implementation but also moderates the relationship between IBL and student achievement. This supports the work of Gess-Newsome et al. (2003), who emphasized that teacher expertise plays a critical role in transforming instructional strategies into measurable student learning gains.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Physics, as a core science subject, is central to technological development and problem-solving in society. However, over the years, students' performance in physics at the secondary school level in Nigeria has remained generally below expectation. This persistent underachievement has been attributed to factors such as traditional teacher-centred instructional approaches, inadequate use of practical methods, limited availability of instructional resources, and insufficient motivation among learners. These challenges have spurred interest in more effective, learner-centred pedagogies such as inquiry-based learning (IBL).

Inquiry-based learning is a constructivist approach that places students at the centre of the learning process, encouraging them to ask questions, explore phenomena, conduct experiments, and derive concepts through active participation. By shifting the focus from rote memorization to exploration and discovery, IBL is believed to improve conceptual understanding, promote critical thinking, and enhance students' interest and achievement in science subjects like physics.

The present study focused on investigating the effectiveness of inquiry-based learning in enhancing students' academic performance in physics in selected secondary schools in Ovia North East Local Government Area of Edo State, Nigeria. It specifically examined the extent to which IBL strategies were employed by teachers, the relationship between IBL and students' performance, and whether factors such as school location, teacher qualification, teacher gender, and school ownership influenced this relationship.

A descriptive survey research design was adopted, and data were collected from physics teachers and students across urban and rural schools in the study area. Standardized questionnaires and achievement tests were employed to gather data on the use of IBL strategies and students' performance in physics. The data were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics (t-test) at a 0.05 level of significance.

The findings revealed that the use of inquiry-based learning strategies significantly improved students' performance in physics. Schools where teachers employed IBL approaches recorded higher mean performance scores than those that relied predominantly on lecture-based methods. The study also found significant differences in the relationship between IBL and students' performance based on school location, teacher qualification, and teacher gender, suggesting that contextual and professional factors affect the effective use of inquiry-based teaching methods.

The study concluded that integrating IBL strategies into physics instruction can substantially enhance students' academic outcomes. It recommended that physics teachers should be trained and encouraged to adopt inquiry-based strategies, that schools especially in rural areas should be provided with adequate facilities and resources to support IBL, and that curriculum developers and policymakers should integrate inquiry-oriented activities into physics curricula. Overall, this study underscores the potential of inquiry-based learning to transform the teaching and learning of physics in Nigerian secondary schools, thereby improving students' understanding, performance, and interest in the subject.

Conclusion

This study examined the role of inquiry-based learning (IBL) in enhancing students' performance in Physics in selected secondary schools in Ovia North East Local Government Area, Edo State, Nigeria. The findings revealed that students who were exposed to IBL strategies generally demonstrated higher levels of understanding, critical thinking, and improved academic performance in Physics compared to those taught with traditional lecture-based approaches. The study further showed that IBL encourages active participation, collaborative learning, and problem-solving skills, which are essential for mastering Physics concepts. Factors such as teachers' qualifications, school ownership, location, and gender were found to influence, to varying degrees, the effectiveness of IBL on students' performance. However, the evidence consistently supports that IBL is more effective than conventional methods in promoting deeper conceptual understanding of Physics.

Based on these findings, the study concludes that the consistent and well-structured application of inquiry-based learning strategies can significantly improve students' academic achievement in Physics. It emphasizes the need for teachers to integrate IBL practices such as guided questioning, experimentation, collaborative investigations, and reflective discussions into their teaching to foster inquiry skills and better learning outcomes.

Recommendations

Based on the findings of this study on inquiry-based learning (IBL) and students' performance in physics in selected secondary schools in Ovia North East L.G.A., Edo State, the following recommendations are made to improve teaching, learning outcomes, and future research.

1. Teachers should design lessons that begin with questions or problems, incorporate hands-on investigations, and guide students to formulate and test hypotheses rather than relying solely on lecture.
2. Teachers should use formative assessment aligned with inquiry. Frequent short assessments (concept maps, lab reports, reflective journals) should be used to monitor student understanding and inform instruction during the inquiry cycle.

3. Teacher should Provide scaffolded inquiry tasks for lower-performing students (guided inquiry) and more open investigations for higher-performing students to maintain accessibility while promoting deeper thinking.
4. School Administrators should provide time and resources for practical work. Schools should allocate timetable blocks for laboratory/investigative activities and budget for basic lab materials, measuring tools, and consumables to support IBL.
5. School Administrators should facilitate teacher collaboration and mentoring. Create peer-observation, lesson-study, or mentoring programs where teachers can share IBL lesson plans, observe one another, and collaboratively improve practice.

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APPENDIX 1

INSTITUTE OF EDUCATION
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QUESTIONNAIRE ON INQUIRY-BASED LEARNING IN ENHANCING STUDENTS' PERFORMANCE IN PHYSICS: A CASE STUDY OF SELECTED SECONDARY SCHOOLS IN OVIA NORTH EAST L.G.A, EDO STATE NIGERIA

Dear Respondent,

The researcher is a postgraduate student of the Institute of Education, University of Benin. The information being sought for is to enable him complete his research work. This research work is purely for academic purpose; as such you are enjoined to kindly and truthfully assist to provide answers to the questions below. Your responses will be treated with utmost confidentiality.

Thanks.

Joseph Aghimien

Fill in the blank

Keys: Strongly Agree (SA), Agree (A), Strongly Disagree (SD), Disagreed (D)

Instruction: Please tick in the space [√] or write down when required.

1. **Sex:** Male [ ] Female [ ]
2. **Age :** 12-14 yrs [ ], 15-17 yrs [ ], 17-19 yrs [ ], 19 and above…...
3. **Class:** JSS 1**-** 3 [ ], SS 1-3 [ ]
4. **Religion:** Christianity [ ] Islam [ ] Others [ ] None [ ]

S/N	Questionnaire Items	SA	A	SD	D
	Is there any relationship between the level of use of inquiry-based learning strategies and the academic performance of students in physics in Ovia North East LGA				
1	I frequently use inquiry-based learning strategies in teaching physics.				
2	The use of inquiry-based learning strategies improves students' understanding of physics concepts.				
3	Students taught using inquiry-based learning strategies perform better in physics tests.				
4	Inquiry-based learning encourages active participation of students in physics lessons.				
	Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school location				
5	Inquiry-based learning is used more frequently in urban schools than rural schools.				
6	Students in urban schools benefit more from inquiry-based learning than those in rural schools.				
7	School location influences how inquiry-based learning is implemented in physics classes.				
8	The availability of resources for inquiry-based learning differs between urban and rural schools.				
	Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on school ownership				
9	Public schools use inquiry-based learning more than private schools.				
10	Students in private schools perform better when inquiry-based learning is applied in physics.				
11	School ownership affects the implementation of inquiry-based learning in physics teaching.				
12	Teachers in private schools are more trained in inquiry-based learning strategies than those in public schools.				
	Is there any difference in the relationship between the use of				

	inquiry-based learning and students' performance in physics based on the sex of teachers				
13	Male teachers use inquiry-based learning strategies more than female teachers.				
14	Female teachers are more effective in using inquiry-based learning in physics than male teachers.				
15	The sex of a teacher influences how inquiry-based learning is applied in the classroom.				
16	Students' performance in physics varies depending on whether the teacher is male or female when using inquiry-based learning.				
	Is there any difference in the relationship between the use of inquiry-based learning and students' performance in physics based on the qualification of teachers				
17	Teachers with higher qualifications apply inquiry-based learning more effectively in physics.				
18	The qualification of teachers affects the quality of inquiry-based learning in physics teaching.				
19	Students taught by more qualified teachers perform better in physics using inquiry-based learning.				
20	Less qualified teachers are less likely to adopt inquiry-based learning strategies in physics.				