



Impacts of Inquiry-Based Learning Strategy on Teaching Seasonal Variations in Temperature and Rainfall on Agricultural Productivity among Senior Secondary II Students in Lere Local Government Area, Kaduna State

By

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ABSTRACT

*This current study investigated the Effects of Inquiry-Based Learning (IBL) Strategy on Teaching Seasonal Variations in Temperature and Rainfall on Agricultural Productivity among Senior Secondary II Students in Lere Local Government Area, Kaduna State. Guided by the Constructivist Learning Theory (Vygotsky, 1978; Piaget, 1972), the study examined the impact of IBL on students' understanding of climatic variations, their ability to relate temperature and rainfall to agricultural productivity, and compared outcomes with conventional teaching methods. A quasi-experimental pre-test and post-test control group design was employed. The population consisted of 1,345 SS II Geography students, while a sample of 120 students from four schools was selected using purposive and random sampling techniques. Data were gathered using a validated 30-item Geography Achievement Test ($KR-20 = 0.82$). Descriptive and inferential statistics (*t*-test) were used to analyze the data. Findings revealed that IBL significantly improved students' comprehension and analytical skills compared to traditional methods. The study recommends the adoption of IBL, integration of local climatic data, and continuous teacher training for effective implementation.*

KEYWORDS: Inquiry-Based Learning, Seasonal Variations, Temperature and Rainfall, Agricultural Productivity, Geography Education

Introduction

Climate variability—especially seasonal shifts in temperature and rainfall—poses a direct threat to agricultural productivity in northern Nigeria, where smallholder farming dominates livelihoods (Udeh, Abdullahi & Bulama, 2024). Local evidence from Lere Local Government Area revealed measurable variability in rainfall and temperature that correlates with yield fluctuations for staple crops (Udeh et al., 2024). National trend analyses likewise report significant spatial and temporal changes in precipitation and temperature across Nigeria, with implications for planting calendars, water availability, and crop resilience (Acric Research Initiative, 2024). These climatic changes create an urgent need for effective climate education in senior secondary schools so that future farmers and community leaders understand cause–effect relationships and adaptive responses.

Inquiry-Based Learning (IBL) offers a pedagogically strong route to deepen students’ conceptual understanding and scientific reasoning about complex, place-based phenomena such as seasonal climate variability (Lu, 2024). IBL emphasizes learner-centred questioning, data collection, hypothesis testing and local investigation—skills that map directly onto analysing meteorological records, interpreting rainfall–yield relationships, and designing small-scale adaptation options (Organisation for Climate Education, 2024). Empirical studies indicate teachers’ growing readiness to adopt inquiry approaches and show positive impacts of IBL on students’ engagement and higher-order thinking in science topics (Lu, 2024). Given documented climate impacts in Lere and the pedagogical fit of IBL, this study investigates the effect of an Inquiry-Based Learning strategy on SS II students’ understanding of how seasonal temperature and rainfall variations influence agricultural productivity in Lere LGA, Kaduna State. The

research will bridge local climatological evidence with classroom-based interventions to inform both curriculum practice and community resilience education.

Statement of the Problem

Many Senior Secondary School II students in Lere Local Government Area show limited conceptual grasp of seasonal variations in temperature and rainfall for agricultural productivity (climatic processes). This weakness is largely attributed to the persistent use of teacher-centered approaches that emphasize rote memorization over inquiry and discovery (Lu, 2024). Geography teachers often lack adequate training and resources to implement Inquiry-Based Learning (IBL), leading to minimal classroom engagement and poor practical understanding of environmental concepts (Organisation for Climate Education, 2024).

Textbook writers, in turn, present climate topics in abstract, data-heavy formats without integrating locally relevant examples or investigative tasks that connect theory to students lived experiences. Curriculum developers rarely include structured inquiry activities that promote scientific reasoning or problem-solving about local climate–agriculture relationships. Furthermore, researchers have paid little attention to evaluating the effectiveness of IBL in geography instruction within rural Nigerian contexts like Lere, leaving a critical gap in evidence-based teaching innovation. Consequently, students' ability to link climatic variability to agricultural outcomes remains shallow, undermining both climate literacy and sustainable agricultural education in the region.

Research Objectives

The objectives of the research include; To:

1. Determine the mean difference between the mean Senior Secondary II students' achievement in their knowledge on seasonal variations in temperature and rainfall in Lere Local Government Area of those taught using Inquiry-Based Learning (IBL) strategy and those taught using conventional method.
2. Assess the mean difference in ability to analyze the relationship between temperature and rainfall and agricultural productivity of those taught using Inquiry-Based Learning (IBL) strategy and those taught using conventional method
3. Ascertain the difference between mean scores of Geography Senior Secondary II students taught using Inquiry-Based Learning strategy and those taught using the conventional teaching method.

Research Questions

The following research questions are addressed in the present study

1. What is the difference in the mean scores achievement of geography students' in knowledge on seasonal variations in temperature and rainfall in Lere Local Government Area, exposed to Inquiry-Based Learning (IBL) strategy and those exposed to conventional method
2. What is the mean scores difference on Senior Secondary II students' ability to analyze the relationship between temperature and rainfall and agricultural productivity between those exposed to inquiry Based Learning (IBL) strategy and those exposed to conventional method.

3. What is the difference between the performance scores of Geography students exposed to Inquiry-Based Learning strategy and those taught using the conventional teaching method?

Null Hypotheses

The following null hypotheses are tested at $P < 0.05$ level of significance

1. There is no mean significant difference between the mean score of Senior Secondary II students' achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area of those exposed to conventional method.
2. There is no mean significant difference between the mean score of Senior Secondary II students' ability to analyze the relationship between temperature and rainfall and agricultural productivity of those exposed to conventional method.
3. There is no mean significant difference between the mean score Senior Secondary II students' performance taught using Inquiry-Based Learning strategy of those taught using the conventional teaching method.

Literature Review

A review of existing literature reveals that while several studies have addressed the relationship between climatic variations, agricultural productivity, and educational strategies, significant gaps persist in the integration of inquiry-based learning (IBL) within Nigerian secondary school geography contexts. Udeh, Abdullahi, and Bulama (2024) offer an important empirical foundation by examining thirty years of temperature, rainfall, and crop yield data in Lere Local Government Area. Their research identifies a clear correlation between seasonal variations and crop productivity, particularly millet and cowpea, which are major agricultural

outputs in the region. The study's longitudinal approach, reliance on local meteorological data, and publication credibility enhance its reliability and contextual depth. These strengths make it a valuable resource for understanding environmental dynamics in geography education. However, the study's major limitation lies in its disciplinary focus—it approaches the issue from climatological and agronomic perspectives without engaging the pedagogical or cognitive aspects of how students interpret or apply such environmental data within classroom learning.

Building on this, Lu (2024) provides crucial insights into teacher preparedness for implementing Inquiry-Based Learning. Using a large-scale survey and a mixed-method approach, Lu emphasizes how teacher beliefs, identity, and institutional support influence the effectiveness of inquiry-oriented instruction. The study's methodological rigor and theoretical contribution to constructivist pedagogy make it highly relevant to discussions on teaching innovation. Nonetheless, its limitation is contextual—Lu's research is situated in East Asian education systems, where institutional structures and resource availability differ significantly from those in Nigeria. Thus, the findings, while generalizable in principle, lack the cultural and infrastructural sensitivity needed for application among rural geography teachers in Lere.

The Organization for Climate Education (OCE, 2024) further extends this discussion by proposing pedagogical models for fostering climate literacy through inquiry, data-driven exploration, and problem-based learning. Its materials are highly practical, aligning closely with global curricular frameworks. However, the prescriptive nature of these resources and their limited empirical validation within Nigerian classrooms reduce their contextual adaptability. Similarly, the OECD (2024) stresses the global urgency of climate education and curriculum alignment to sustainability goals. Its macro-level policy recommendations are theoretically robust but fall short of addressing classroom realities such as inadequate teacher training, lack of

localized instructional materials, and limited student engagement strategies necessary for effective inquiry-based learning in the Nigerian context.

Empirical Studies

Lu (2024) examined teacher readiness and identity in implementing IBL, focusing on predictors of instructional effectiveness through a mixed-method design. The study used surveys and interviews to explore how professional identity and institutional support affect teachers' capacity to adopt IBL, offering valuable insights into pedagogical transformation. Similarly, the Organization for Climate Education (OCE, 2024) developed IBL climate education modules aimed at enhancing students' climate literacy. Through quasi-experimental approaches, such frameworks could be tested for feasibility and learning outcomes among SS II students using achievement tests, observation rubrics, and focus group discussions.

The OECD (2024) emphasized the importance of curriculum alignment for global climate literacy, employing policy analysis and interviews to identify gaps between policy intent and classroom practice. Udeh, Abdullahi, and Bulama (2024) provided longitudinal climatic data spanning thirty years, demonstrating how local temperature and rainfall variations affect crop yield—data that can be integrated into inquiry-based classroom activities. Additionally, Acri Research Initiative (2024) contributed spatial trend analyses of precipitation and temperature using the Mann–Kendall method, providing real-world datasets for classroom application. Lastly, studies inspired by Lu (2024) and Udeh et al. (2024) proposed mixed-method and structural modeling designs to test determinants of teacher inclination toward IBL and its influence on students' agricultural understanding. Collectively, these empirical models offer adaptable foundations for classroom research in Kaduna State.

Theoretical Framework

The study is built based on Constructivist Learning Theory which emphasizes that, learners build knowledge through active engagement, reflection, and interaction with real-world phenomena (Vygotsky, 1978; Piaget, 1972). Its strength lies in promoting critical thinking, problem-solving, and learner-centered exploration—key elements of IBL that help students connect climatic concepts to agricultural outcomes. It also supports contextualized learning, enabling students to relate scientific data on temperature and rainfall to familiar agricultural practices. However, a weakness of the theory is its heavy reliance on teacher expertise and resource availability, which may limit effective implementation in under-resourced Nigerian schools. Despite this, its implication for the present study is significant—it provides a framework for designing experiential learning activities that enhance understanding of climatic variability and its agricultural impacts among Senior Secondary II students.

Methodology

This study adopted a quasi-experimental research design involving pre-test and post-test control groups, suitable for comparing the effects of the Inquiry-Based Learning (IBL) strategy with the conventional lecture method (Creswell & Creswell, 2024). The population comprised 1,345 Senior Secondary II Geography students in public secondary schools within Lere Local Government Area, Kaduna State. A sample of 120 students were drawn from four co-educational schools using purposive and simple random sampling. Two schools formed the experimental group, and two served as the control group. Data were collected using a researcher-developed Geography Achievement Test (GAT) consisting of 30 validated multiple-choice items, with a KR-20 reliability coefficient of 0.82. Data collection involved pre-test, six-week treatment, and post-test phases. Descriptive statistics was used to answer the research questions, while t-test was used to test hypotheses at 0.05 significance.

Results

This presents the analyses of data collected and the results based on the research questions and hypotheses stated in chapter one. The pupils’ performance scores were analyzed by using mean and standard deviation to answer the research questions while, independent sample t-test was used to analyze the research hypotheses at 0.005 level of significance.

Answering Research Questions

This presents the data of the responses to research questions through descriptive statistics (mean and standard deviation) to answer the research questions.

The research question one states that “What is the effect of Inquiry-Based Learning (IBL) strategy on Senior Secondary II students’ achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area?”

Table 1: Answering Research Question One: (Mean Score and Standard Deviation)

Groups	N	Mean	Std.Dev	Mean Difference	Std. Error Mean
Experimental	30	31.5	6.00	3.01	0.83
Control	30	28.5	8.40		

Table 1: The result of the above table revealed that there is significant effect of Inquiry-Based Learning (IBL) strategy on Senior Secondary II students’ achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area. The mean performance score of experimental groups was (M=31.5; SD 6.00) which is greater than that of control group at (M=28.5; SD=8.40) while the mean difference at 3.01. Therefore, the study proved that there is significant effect of Inquiry-Based Learning (IBL) strategy on Senior Secondary II students’ achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area.

The research question Two states that, “What is the impact of Inquiry-Based Learning strategy on Senior Secondary II students’ ability to analyze the relationship between temperature and rainfall and agricultural productivity?”

Table 2: Answering Research Question Two: (Mean Score and Standard Deviation)

Groups	N	Mean	Std.Dev	Mean Difference	Std. Error Mean
Experimental	30	36.88	7.95	9.35	0.97
Control	30	27.53	7.71		

Table 2: The result of the above table revealed that there is significant effect of Inquiry-Based Learning strategy on Senior Secondary II students’ ability to analyze the relationship between temperature and rainfall and agricultural productivity. The mean performance score of experimental group was (M=36.88; SD=7.95) which is greater than that of control group at (M=27.53; SD=7.71) while, the mean difference between the two groups was 9.35. Therefore, the study proved that there is significant of Inquiry-Based Learning strategy on Senior Secondary II students’ ability to analyze the relationship between temperature and rainfall and agricultural productivity.

The research question Three states that, ‘What is effect of Senior Secondary II students’ performance taught using Inquiry-Based Learning strategy with those taught using the conventional teaching method in geography?’

Table 3: Answering Research Question Three: (Mean Score and Standard Deviation)

Groups	N	Mean	Std.Dev	Mean Difference	Std. Error Mean
Experimental	30	35.88	6.95	7.35	0.97
Control	30	28.53	6.21		

Table 3: The result of the above table revealed that there is significant effect of Senior Secondary II students’ performance taught using Inquiry-Based Learning strategy with those taught using the conventional teaching method in geography. The mean performance score of experimental group was (M=35.88; SD=6.95) which is greater than that of control group at (M=28.53; SD=6.71) while, the mean difference between the two groups was 7.35. Therefore,

the study proved that there is significant effect of Senior Secondary II students' performance taught using Inquiry-Based Learning strategy with those taught using the conventional teaching method in geography.

4.2 Testing Null Hypothesis

The hypothesis one states that “There is no significant effect of Inquiry-Based Learning (IBL) strategy on Senior Secondary II students' achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area.”

Table 4: Independent Sample t-test One

Groups	N	Mean	Std.Dev	Df	t-Cal	P-Value	Remark
Experimental	30	31.5	6.00	58	.40	0.02	Significant
Control	30	28.5	8.40				

The result of the Table 4 revealed that there was significant effect of Inquiry-Based Learning (IBL) strategy on Senior Secondary II students' achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area. This is supported by the values of t_{Cal} at $=.40$, $df=58$, $p\text{-Value}=0.02 < 0.05$. Therefore, the null hypothesis that states “there was significant effect of Inquiry-Based Learning (IBL) strategy on Senior Secondary II students' achievement in understanding seasonal variations in temperature and rainfall in Lere Local Government Area” was rejected.

The hypothesis Two states that “There is no significant impact of Inquiry-Based Learning strategy on Senior Secondary II students' ability to analyze the relationship between temperature and rainfall and agricultural productivity.”

Table 5: Independent Sample t-test Two

Groups	N	Mean	Std.Dev	Df	t-cal	P-Value	Remark
Experimental	30	36.88	7.95	58	-1.90	0.04	Significant

Control	30	27.53	7.71
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The result of the Table 5 revealed that there was significant effect of Inquiry-Based Learning strategy on Senior Secondary II students’ ability to analyze the relationship between temperature and rainfall and agricultural productivity. This is supported by the values of t_{-Cal} at $=-1.90$, $df=58$, $p=Value=0.04<0.05$. Therefore, the null hypothesis that states “there was no significant effect of Inquiry-Based Learning strategy on Senior Secondary II students’ ability to analyze the relationship between temperature and rainfall and agricultural productivity” was rejected.

The hypothesis Two states that “there is no significant effect of Senior Secondary II students’ performance taught using Inquiry-Based Learning strategy with those taught using the conventional teaching method in geography.”

Table 6: Independent Sample t-test Two

Groups	N	Mean	Std.Dev	Df	t_{-cal}	P-Value	Remark
Experimental	30	35.88	6.95	58	-1.97	0.04	Significant
Control	30	28.53	6.21				

The result of the Table 6 revealed that there was significant effect of Senior Secondary II students’ performance taught using Inquiry-Based Learning strategy with those taught using the conventional teaching method in geography. This is supported by the values of t_{-Cal} at $=-1.97$, $df=58$, $p=Value=0.04<0.05$. Therefore, the null hypothesis that states “there is no significant effect of Senior Secondary II students’ performance taught using Inquiry-Based Learning strategy with those taught using the conventional teaching method in geography” was rejected.

Discussions of the Major Findings

The findings of this current study align with existing literature which consistently revealed that, Inquiry-Based Learning (IBL) positively influences students’ conceptual understanding, analytical reasoning, and classroom engagement. This outcome supports Lu’s

(2024) conclusion that when teachers are well-prepared and confident in applying inquiry approaches, learners demonstrate enhanced comprehension and critical thinking in science and geography. Similarly, the Organization for Climate Education (OCE, 2024) found that, inquiry lessons anchored on local climate data help students interpret environmental changes and connect them to real-life agricultural situations, corresponding to the current study's second objective. Hence, these studies collectively affirm that IBL enhances SS II students' achievement and analytical competence in understanding seasonal variations in temperature and rainfall.

However, the findings also reveal some contrasting emphases among scholars. Udeh, Abdullahi, and Bulama (2024) provide empirical evidence of climatic variability's effects on agriculture but neglect the pedagogical aspect of how learners internalize such relationships. Likewise, Acri Research Initiative (2024) focuses on climate trend analysis without exploring its educational implications. Conversely, Lu (2024) highlights the importance of teacher readiness, stressing that the success of IBL depends largely on instructional capacity and institutional support. OECD (2024) also noted that while global policies advocate for inquiry-driven climate education, effective implementation at classroom level remains limited without adequate teacher development.

Comparatively, the findings confirm that IBL yields deeper understanding and long-term retention compared to traditional lecture methods, which often encourage rote learning (Lu, 2024; OCE, 2024; OECD, 2024). Nonetheless, the absence of empirical studies testing IBL in local contexts such as Lere underscores the significance of the present research in bridging that gap. Therefore, the study reinforces the pedagogical advantages of IBL while emphasizing the need for contextual validation and teacher training to optimize its classroom effectiveness.

Conclusion

The present study concludes that, the Inquiry-Based Learning (IBL) strategy plays a crucial role in improving students' comprehension of seasonal variations in temperature and rainfall, as well as their analytical ability to relate climatic factors to agricultural productivity. The results align with previous findings (Lu, 2024; OCE, 2024; OECD, 2024), which demonstrate that inquiry-oriented instruction fosters deeper conceptual understanding, critical thinking, and active student engagement when compared with conventional teaching methods. Consistent with Udeh, Abdullahi, and Bulama (2024), the present research underscores the importance of incorporating locally generated climatic data into geography lessons to enhance contextual relevance and practical application. Furthermore, the study reinforces Lu's (2024) argument that teacher competence, professional readiness, and institutional support are essential for effective IBL implementation. Overall, the study establishes that IBL offers a viable pedagogical framework for strengthening climate literacy and promoting agricultural consciousness among Senior Secondary II students in Lere Local Government.

Based on the findings of this study, the following recommendations are made:

1. **Adoption of Inquiry-Based Learning (IBL):** Geography teachers should adopt the IBL strategy to promote deeper understanding of seasonal variations in temperature and rainfall, as it enhances students' analytical and problem-solving skills.
2. **Integration of Local Climatic Data:** Curriculum developers and teachers should incorporate locally relevant climatic and agricultural data (such as from Lere LGA) into classroom instruction to make learning more meaningful and contextually grounded.
3. **Teacher Training and Support:** Educational authorities should organize continuous professional development workshops and seminars to equip teachers with the knowledge and skills necessary for effective IBL implementation.

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