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Exploring Teachers' Perceptions and Implementation of Inquiry-Based Learning in Secondary School STEM Classrooms in Kaduna State, Nigeria

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Abstract

Inquiry-based learning (IBL) is widely promoted as a pedagogy for developing critical thinking, problem-solving and engagement in Science, Technology, Engineering and Mathematics (STEM) education, yet in-depth qualitative investigation into how secondary school STEM teachers in Kaduna State, Nigeria, experience and enact IBL remains limited. Employing a phenomenological approach within the qualitative paradigm and guided by Diffusion of Innovations (DOI) theory, this study explored the lived experiences of seven purposively selected secondary school STEM teachers (Geography, Mathematics, Basic Science and Technology, Biology, two Physics teachers and Chemistry) from public schools in Kaduna State. Data were generated through semi-structured interviews, transcribed verbatim and analysed thematically with ChatGPT-4o assistance and human cross-validation. Four themes emerged: teachers conceptualised IBL as a learner-centred departure from teacher-centred instruction; they perceived clear advantages for engagement, voice and critical thinking; they described structural barriers, including overcrowded classrooms, scarce materials, time pressure and students' weak academic background, with one teacher never adopting IBL for fear of losing classroom control; and they identified professional development, resources, incentives and supervision as necessary for sustained adoption. Findings suggest teachers hold favourable attitudes toward IBL, but adoption is constrained more by structural than attitudinal factors, warranting sustained institutional investment rather than one-off interventions.

Keywords: inquiry-based learning, STEM education, teachers' perceptions, diffusion of innovations, phenomenology

1 Introduction

Science, Technology, Engineering and Mathematics (STEM) education is widely recognised as a critical driver of national development, innovation and economic competitiveness. Achieving these goals, however, depends not only on curriculum content but also on the pedagogical approaches through which STEM is taught. Inquiry-based learning (IBL) has emerged as one of the most influential learner-centred pedagogies for STEM education because it actively engages learners in questioning, investigating, analysing evidence and constructing knowledge rather than passively receiving information (Wrahatnolo & Munoto, 2018; Sam, 2024; Tan & Kidman, 2025). Despite its documented benefits for conceptual understanding, critical thinking and academic achievement, successful implementation of IBL depends on enabling conditions such as teachers' pedagogical competence, professional development, adequate instructional resources and supportive school environments, and where these conditions are lacking, teachers often struggle to translate inquiry-oriented principles into effective classroom practice (Sam, 2024; Setiyani et al., 2025). The Nigerian educational system formally recognises the importance of inquiry-oriented teaching: the National Policy on Education (2013) and the STEM Education Policy Framework (2019) advocate learner-centred instructional approaches that promote scientific inquiry, creativity and problem-solving. Classroom instruction in many Nigerian secondary schools, however, continues to be characterised by teacher-centred instruction, rote memorisation, and examination-driven content delivery (Uche et al., 2020), a disconnect between policy expectations and classroom realities that limits the development of higher-order thinking skills IBL is intended to cultivate. This gap is compounded by contextual challenges, including inadequately equipped laboratories and workshops that restrict practical, investigative experience (Amie-Ogan & Oguru, 2025) and by teachers' beliefs, pedagogical knowledge and self-efficacy, which substantially shape how instructional innovations are interpreted and enacted (Bandura, 1986; Nikokçeviţ-Kurti et al., 2025).

These issues are particularly salient in Kaduna State, where considerable variation exists in school infrastructure, teacher qualifications, instructional resources and student characteristics across secondary schools. Despite the state's historical standing as a centre of learning and teacher preparation in Northern Nigeria, empirical evidence examining how STEM teachers experience and implement inquiry-based learning remains limited. Existing Nigerian studies have largely relied on quantitative survey designs to measure teachers' attitudes, perceptions, or self-efficacy, offering limited insight into how teachers actually interpret, negotiate and enact inquiry-based pedagogy within the realities of their classrooms. Comparable phenomenological evidence focusing specifically on secondary school STEM teachers' experiences of IBL is currently scarce in this context (cf. Zakariya et al., 2026). This study addresses this gap by exploring the lived experiences of secondary school STEM teachers in implementing inquiry-based learning across STEM subjects in Kaduna State, Nigeria. Specifically, it investigates teachers' understanding of IBL, their classroom implementation practices and the contextual factors that facilitate or hinder its effective adoption. The study addressed the following research questions:

1. How do secondary school STEM teachers in Kaduna State conceptualize inquiry-based learning in relation to traditional teaching methods?
2. What relative advantages do teachers associate with IBL for student engagement and critical thinking?
3. What structural and contextual barriers do teachers encounter when implementing IBL in their classrooms?
4. What conditions do teachers believe are necessary to sustain and scale the adoption of IBL in Kaduna State secondary schools?

Answers to these questions are expected to provide curriculum planners, school leaders and policymakers with grounded, teacher-derived evidence to inform STEM pedagogical reform and professional development investment in Kaduna State and comparable Nigerian contexts.

2 Literature Review/Theoretical Framework

This study was underpinned by the Diffusion of Innovations (DOI) theory (Rogers, 1962, 2003), which explains how new ideas and practices spread within a social system through a five-stage decision process, knowledge, persuasion, decision, implementation and confirmation and identifies five attributes that shape the rate of adoption: relative advantage, compatibility, complexity, trialability and observability. DOI theory further categorises adopters along a continuum from innovators to laggards, based on their readiness to embrace an innovation. Applied to this study, DOI theory helps interpret teachers' accounts of IBL as reflecting different stages of the innovation-decision process: their conceptualisation of IBL reflects the knowledge stage; their reported benefits reflect persuasion; their described barriers reflect perceived complexity; and their expressed conditions for sustained use reflect what is required to move from trial to confirmation. A growing empirical literature situates the present study. A recent systematic review identified limited understanding of inquiry pedagogy, continued reliance on traditional teaching methods, inadequate institutional support, insufficient professional development and time constraints as the most common barriers to IBL implementation across educational contexts (Setiyani et al., 2025). Consistent with this, Arifin et al. (2025) found that inquiry-based approaches meaningfully improve students' critical thinking skills in science education, but that effect sizes vary with the fidelity and duration of implementation, underscoring that positive outcomes are conditional on how well teachers are supported to enact the pedagogy. Similarly, Asante et al. (2025) reported that although many West African mathematics teachers valued inquiry-oriented instruction, those without structured professional development demonstrated low self-efficacy for implementing it effectively and Aidoo (2024) likewise found that reflective, sustained engagement with inquiry-based methods, rather than one-off exposure, was necessary for teachers to move toward confident practice. Collectively, these findings suggest that positive attitudes toward IBL do not necessarily translate into sustained classroom practice.

Within Nigeria specifically, Amie-Ogan and Oguru (2025) observed that many secondary schools lack essential STEM instructional facilities, including adequately equipped laboratories and workshops, thereby restricting the practical and investigative experiences required for effective IBL, while Uche et al. (2020) linked continued teacher-centred instruction to weak alignment between policy and classroom practice. Although teachers with constructivist beliefs are generally more inclined to adopt inquiry-oriented pedagogies (Bandura, 1986; Nikokçeviţ-Kurti et al., 2025), implementation is often constrained by limited instructional time, high-stakes examinations, insufficient professional competence and inadequate institutional support (Aidoo, 2024). Recent phenomenological research on technology acceptance among undergraduate students in Kaduna State demonstrated the value of in-depth qualitative inquiry for revealing the complex, sometimes contradictory experiences underlying educational-innovation adoption (Zakariya et al., 2026), but comparable qualitative evidence on secondary STEM teachers lived experience of IBL remains scarce. This gap limited qualitative, theory-guided evidence on how Kaduna State STEM teachers experience and enact IBL is the central concern this study addresses.

3 Materials and Methods

3.1 Research Design

This study employed a phenomenological approach within the qualitative research paradigm (Creswell & Poth, 2018) to explore the lived experiences of secondary school STEM teachers in implementing inquiry-based learning (IBL) in Kaduna State, Nigeria. According to Creswell and Poth (2018), phenomenology seeks to understand and describe individuals' lived experiences of a particular phenomenon by capturing the meanings participants ascribe to those experiences, while setting aside researchers' preconceived assumptions. This approach was appropriate because it enabled an in-depth exploration of how STEM teachers understand experience and enacts inquiry-based learning in their classrooms, including their perceptions of IBL, their implementation practices, and the contextual factors that facilitate or constrain its effective adoption across STEM disciplines.

3.2 Participants

A purposive sampling technique was used to select seven secondary school STEM teachers (three male, four female) with direct classroom experience of attempting or considering IBL, drawn from public secondary schools in Kaduna State. The sample included teachers of Geography, Mathematics, Basic Science and Technology, Biology, Chemistry and two teachers of Physics, reflecting a broad representation of STEM and STEM-adjacent subjects at the secondary level. Teaching experience ranged from approximately four to over fourteen years. Pseudonyms were assigned to protect participant confidentiality, including for two participants who spontaneously disclosed their names during recording. Table 1 presents participants' pseudonyms, gender, subject taught, highest qualification and years of teaching experience.

Table 1

Participants' Pseudonyms and Other Biodata

SN	Pseudonym	Gender	Subject Taught	Highest Qualification	Years of Experience
1	Malam Sani	Male	Geography	BSc Geography (ABU Zaria)	Not specified (extensive)
2	Malam Bello	Male	Mathematics	NCE (BSc in view)	14 years
3	Hajiya Amina	Female	Basic Science & Technology	MSc Integrated Science (ABU Zaria)	10 years
4	Malama Zainab	Female	Biology	NCE (Basic Science) & BSc Biology	Approx. 10–20 years (unclear)
5	Malam Umar	Male	Physics	Physics degree (institution unspecified)	~9 years (since 2016)
6	Malama Ladi	Female	Physics	BSc Physics (ABU Zaria)	4 years
7	Malama Hauwa	Female	Chemistry	Degree, ABU Zaria (unspecified)	6 years

Table 1 shows that participants collectively represent core STEM and STEM-related secondary school subjects and a range of teaching experience and qualification levels, from Nigeria Certificate in Education (NCE) holders to a Master of Science degree holder, providing a broad basis for exploring shared and divergent experiences of IBL across disciplinary and professional backgrounds.

3.3 Data Collection

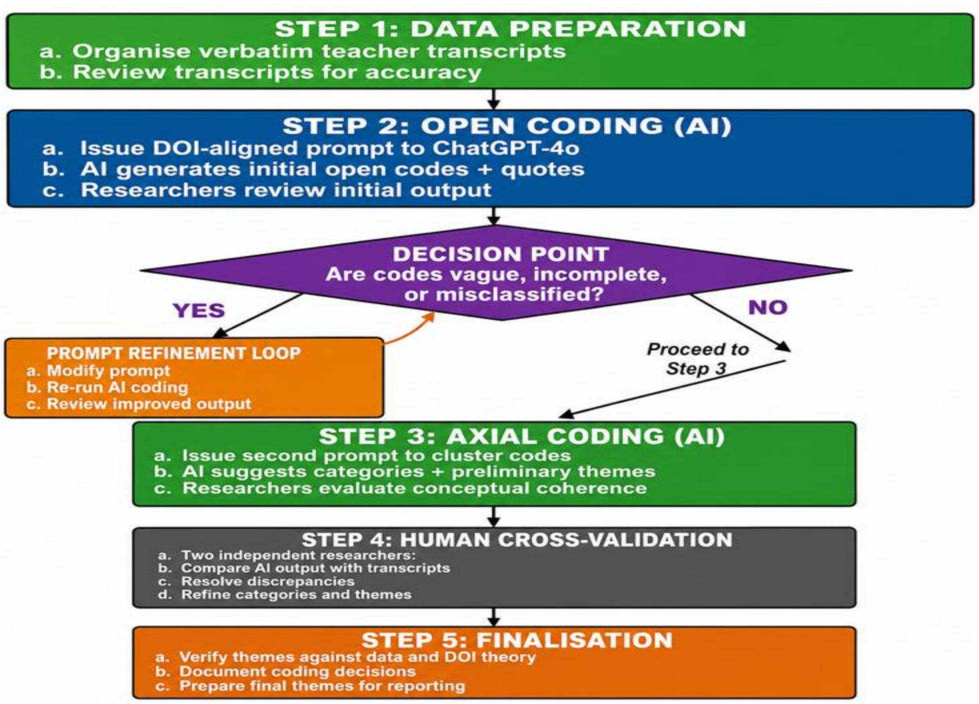
Data were collected through individual semi-structured interviews guided by a self-developed interview protocol informed by DOI theory. The protocol comprised four sections aligned with the study's research questions: conceptualisation and compatibility of IBL with existing teaching practice; perceived relative advantage for student engagement, participation and critical thinking; perceived complexity and implementation barriers, including class size, instructional materials, curriculum requirements and examination pressure; and facilitating conditions believed necessary for sustained adoption, including professional development, resource support, and the roles of school leadership and policymakers. Interviews were conducted in participants' preferred language register, audio-recorded with consent, and transcribed verbatim for thematic analysis. All participants provided consent for their responses to be recorded and used for research purposes, with confidentiality maintained through pseudonymisation at the transcription and reporting stage.

3.4 Data Analysis

Data analysis followed a comprehensive, multi-step approach based on the guidelines of Creswell and Poth (2018), and modelled on the AI-assisted qualitative analysis framework applied in a related phenomenological study of technology acceptance in Kaduna State higher education (Zakariya et al., 2026). Verbatim transcripts were first organised and reviewed for accuracy and familiarisation. ChatGPT-4o was then used to support open coding: structured, theory-aligned prompts directed the system to identify meaningful units of data, extract direct participant quotations, and generate discrete codes grounded in the transcripts. AI-generated codes were not adopted automatically; the research team reviewed each set of codes for accuracy, relevance, and conceptual alignment with the raw data, refining and reissuing prompts where codes were vague, incomplete, or misclassified. A second set of prompts then supported axial coding, clustering refined codes into coherent categories and candidate themes consistent with DOI theory and the study's objectives. Two independent researchers subsequently cross-validated the AI-generated categories and themes against the verbatim transcripts, resolved discrepancies through discussion and finalised the themes presented below. This researcher-supervised, multi-stage procedure ensured that AI-assisted coding served as a complementary analytical aid rather than a substitute for human interpretive judgment.

Figure **1**

AI-Assisted Qualitative Data Analysis Framework, Adapted for the Diffusion of Innovations-Aligned Study of Teachers' IBL Experiences



Adapted from "Computer-Based Testing in Higher Education: A Phenomenology Investigation into Undergraduate Students' Perspectives Through the Technology Acceptance Model," by Y. F. Zakariya, S. B. Alotaibi, J. S. Alrashood, and T. M. Alrosaa, 2026, *Frontiers in Psychology, 17*, Article 1602964 (https://doi.org/10.3389/fpsyg.2026.1602964). CC BY 4.0.

4 Results

Analysis of the seven transcripts yielded four major themes, corresponding to the study's four research questions: (1) conceptualising IBL as learner-centred pedagogy; (2) perceived relative advantage of IBL for engagement and critical thinking; (3) structural and contextual barriers to implementation; and (4) conditions necessary for sustained and scaled adoption. Each theme and its subthemes are presented below with supporting quotations attributed to participant pseudonyms.

4.1 Theme 1: Conceptualising IBL as Learner-Centered Pedagogy

All seven participants, irrespective of subject specialism or years of experience, independently converged on a definition of IBL centred on shifting instructional agency from the teacher to the student, and consistently contrasted this with a teacher-dominated traditional method.

4.1.1 Definitional consensus on student-centeredness

"IBL is something that has to do with, you know, student centered… if anything has to do with the student that's centered on the student, I think it helps them better. Because mostly teaching is about the student, not only the teacher." (Malam Sani, Geography)

"Inquiry-based learning methods, I consider, is one of the best methods… you just give them the necessary things they will need… they learn by asking, by doing research, by investigation." (Malam Bello, Mathematics)

"The inquiry-based learning is a teaching or learning strategy that has to do with a learner-centered approach of teaching… there should be resources or materials that will aid or guide the students in how to carry out those activities to make the learning meaningful." (Hajiya Amina, Basic Science & Technology)

"Inquiry-based learning is when you ask students, you just guide them on one topic… you use student centered teaching methods so that you let them to understand this, to bring the idea by themselves, but you just need to guide them." (Malama Zainab, Biology)

4.1.2 Contrast with teacher-centered “talk-and-chalk” tradition

"Traditional method has to do with only, you know, going with materials, the writing note and all… mostly it has to do with the teacher." (Malam Sani, Geography)

"Unlike the teaching, or the traditional one, that we're doing to teach students by chalk and duster… IBL is the best way of teaching students to learn by himself." (Malam Umar, Physics)

"IBL gives the learners the avenue to really participate in the teaching activity, while the traditional teaching method has to do with the teacher doing almost 90% of the teaching activity." (Malama Hauwa, Chemistry)

Consistent with DOI theory's knowledge stage, these accounts show that participants share a clear, largely convergent conceptual understanding of IBL as a learner-centred pedagogy, distinguished from traditional instruction primarily by who holds instructional agency in the classroom, a shared frame that underlies all subsequent themes.

4.2 Theme 2: Perceived Relative Advantage of IBL for Engagement and Critical Thinking

Participants described specific, often vivid, classroom episodes in which IBL appeared to enhance student participation, confidence, and higher-order thinking, reflecting DOI theory's relative advantage attribute.

4.2.1 Increased participation, confidence, and voice

"It makes students feel free to ask questions… the engagement here is that all the students are involved… every one of them, you see them competing that yes, my answer could be the best." (Malam Bello, Mathematics)

"It makes you see your students, it makes you know your students, it makes the students feel seen, it makes your students feel heard." (Malama Ladi, Physics)

"Even in terms of exposure or for them to be able to speak and all those kinds of things, it really, really helps them a lot." (Malam Sani, Geography)

4.2.2 Development of critical thinking and problem-solving

"It definitely helps students in developing critical thinking… I asked them a question that in what situation can you carry ice from here to ABU in a sip… one of the students got the answer… all of them agreed that yes, it is true." (Malam Bello, Mathematics)

"Yes, it does. It will help them… it will make them want to go into research because they will want to know what you are teaching." (Malama Ladi, Physics)

"By allowing students to use their hands in conducting experiments, they are using their brains at once, simultaneously. So that gives them that critical thinking." (Malama Hauwa, Chemistry)

4.2.3 Durable understanding through concrete inquiry episodes

Several teachers offered memorable, subject-specific vignettes illustrating how inquiry episodes translated into lasting understanding, reflecting DOI theory's observability attribute — the extent to which the results of an innovation are visible to teachers and peers.

"I asked them what they understand [about soil]. So, most of them were seeing me sand, sand, sand… I think that class was very, very good, you know, memorable and it was quite interesting because the students were engaging." (Malam Sani, Geography)

"A stove was brought, then we have a pot, then water… when it started boiling… we raised the lid… this is an example of evaporation… we saw droplets of water… it's just like an example of condensation." (Hajiya Amina, Basic Science & Technology)

"When I entered NECO [examination hall] and was invigilating, I saw them doing it [the practical] perfectly the way I taught them in class. So I was happy." (Malam Umar, Physics).

4.2.4 A divergent view: reduced long-run teacher burden

"The way I can distinguish or differentiate between the traditional teaching method and this IBL is that it makes the teacher less stressed… though it may take time before you acquire what you want to achieve." (Malama Zainab, Biology)

This last observation stands apart from the majority view, discussed further below, that IBL is more time-consuming and demanding for teachers, a tension that appears to reflect this participant's simultaneous concern about losing classroom control, discussed in Theme 3.

4.3 Theme 3: Structural and Contextual Barriers to Implementing IBL

Despite broadly favourable attitudes, participants described substantial structural constraints on their ability to implement IBL routinely, corresponding to DOI theory's complexity attribute, the degree to which an innovation is perceived as difficult to use within existing conditions.

4.3.1 Overcrowded classrooms

"Each of the class is having students more than 100, from 100 to 150. We find it very difficult… that is why I say it is time consuming." (Malam Bello, Mathematics)

"Imagine teaching a class alone with 160 students, and it required you to use 35 minutes for that period." (Hajiya Amina, Basic Science & Technology)

"I have about 100 students in a class. So even grouping them, I have to make it like in clusters… in 10 groups before I'll be able to get at least few students in each group." (Malama Ladi, Physics)

4.3.2 Scarcity of instructional materials and infrastructure

"We don't really, really have all these instructional materials that we normally require… most times if you even ask, they ask you to improvise, and improvising has to do with money." (Malam Sani, Geography)

"There's a need of government intervention for us in equipping the practical laboratories… the electricity, if you want to perform a practical of electricity, there's no light in our community." (Malam Umar, Physics)

"Class size is a major barrier to IBL… the instructional materials, if the teacher needs to use the IBL, he might use something like a slide projector… but in public school, it's inaccessible basically for now." (Malama Hauwa, Chemistry)

4.3.3 Time pressure from curriculum coverage and examinations

"It is time consuming… if you engage 100% in using it, definitely for you to cover, you will not be able to cover a given topic within the time expected." (Malam Bello, Mathematics)

"We have bulky topics that we need to cover within a term… if we base on this IBL, we won't be able to do it." (Malama Zainab, Biology)

"The academic session is short… so we find it difficult to cover the subject… that we're supposed to cover in the term." (Malam Umar, Physics)

4.3.4 Students' weak academic and socioeconomic background

"Most of the students find it very, very difficult… I don't know, maybe it's because of their background… some of them can't even talk or they can't even express themselves." (Malam Sani, Geography)

"Most of them are coming from poor background. You see, if they go home, they will not have any source to get that information… they don't have the phone that they can browse." (Malam Bello, Mathematics)

4.3.5 Fear of losing classroom control

One participant, uniquely among the sample, reported never having used IBL, attributing this directly to a fear of losing instructional control over a large class of young learners, an account that illustrates how perceived complexity can prevent an innovation from ever being trialled.

"No, I haven't [tried] using it, because of fear that the students can, we change the class to another thing… they may change your class to something else… they may change this to a marketplace where they are buying and selling." (Malama Zainab, Biology)

4.4 Theme 4: Conditions for Sustained and Scaled Adoption of IBL

When asked what would support continued or expanded use of IBL, participants converged on a small set of institutional conditions, corresponding to what DOI theory frames as requirements for moving from trial to confirmed, routine adoption.

4.4.1 Structured professional development and training

"If teachers should engage, or if the government should think of all these kinds of programmes… the teachers will have better experience and they will have better knowledge of the methods." (Malam Sani, Geography)

"I think organising seminars, workshops, STEM trainings and the rest can help teachers to know much about this IBL, to know how to ask the questions, when to ask the questions." (Malama Ladi, Physics)

4.4.2 Provision of instructional materials and infrastructure

"Government should provide a lot of classes, and then they should also provide instructional materials, adequate instructional materials that they can be able to use for the student to be able to see and understand." (Malam Sani, Geography)

"Our libraries, our laboratories, our computer laboratories, science laboratories should be fully equipped so that learners will be able to satisfy their curiosity." (Malama Ladi, Physics)

4.4.3 Financial incentives for teachers

"The best recommendation here is, you know, finance… they should bring a system whereby they can provide incentives for the teachers so that they should be able to use IBL in their practising." (Malam Sani, Geography)

4.4.4 Skepticism rooted in prior unsupervised interventions

One participant offered a cautionary account of a previous government-sponsored technology initiative, suggesting that teachers' willingness to embrace future interventions is shaped by past experience of poor accountability and follow-through, a consideration DOI theory situates within the broader social system surrounding an innovation.

"There was a time we were taken to [a training centre] for a workshop, and we were trained on how to use tablets… at the end of it, work done was equal to zero. The tablets were supplied to some selected schools, while some are left behind… they are using it for their own personal use." (Malama Hauwa, Chemistry)

4.4.5 Advocacy and supervisory role of school leadership

"The principal, as a leader, he can bring all these kinds of programmes that will be able to help the teachers where they're lacking in the method… introduce workshops for them to add more to their knowledge." (Malam Sani, Geography)

"Adequate supervision is very necessary so that the teachers will be supervised on how they are implementing the IBL on learners." (Malama Hauwa, Chemistry)

Table 2

Summary of Themes and Subthemes from the Study

Theme	Subthemes	Core Insight
1. Conceptualising IBL as Learner-Centered Pedagogy	1.1 Definitional consensus on student-centeredness 1.2 Contrast with teacher-centered "talk-and-chalk" tradition	Teachers uniformly frame IBL as a departure from teacher-dominated instruction toward guided student self-discovery.
2. Perceived Relative Advantage of IBL	2.1 Increased participation, confidence, and voice 2.2 Development of critical thinking and problem-solving 2.3 Durable understanding through concrete inquiry episodes 2.4 Divergent view: reduced long-run teacher burden	IBL is perceived as enhancing engagement and higher-order thinking, illustrated through vivid classroom vignettes across disciplines.
3. Structural and Contextual Barriers to Implementation	3.1 Overcrowded classrooms 3.2 Scarcity of instructional materials and infrastructure 3.3 Time pressure from curriculum coverage and examinations 3.4 Students' weak academic/socioeconomic background 3.5 Fear of losing classroom control	Structural constraints, more than attitudinal resistance, are the dominant obstacles; one teacher has never adopted IBL due to anticipated loss of control.
4. Conditions for Sustained and Scaled Adoption	4.1 Structured professional development and training 4.2 Provision of instructional materials and infrastructure 4.3 Financial incentives for teachers 4.4 Skepticism from poorly monitored past interventions 4.5 Advocacy and supervisory role of school leadership	Teachers link long-term, confirmed adoption of IBL to sustained institutional investment rather than one-off, unsupervised interventions.

5 Discussion

Findings of this study reveal that secondary school STEM teachers in Kaduna State hold a shared, coherent conceptual understanding of IBL as learner-centred pedagogy, consistently contrasted against a teacher-dominated traditional method.

Interpreted through DOI theory (Rogers, 2003), this shared conceptualisation corresponds to the knowledge stage of the innovation-decision process: teachers across disciplines and experience levels have acquired a common understanding of what IBL is and how it differs from conventional instruction, even where formal training in the method has been limited or absent, as several participants explicitly noted. Teachers overwhelmingly perceived IBL as offering clear relative advantages for student engagement, voice, and critical thinking, illustrated through concrete, often memorable classroom vignettes spanning geography, mathematics, basic science, and physics. This finding is consistent with broader evidence that IBL can enhance motivation and higher-order thinking when implemented, even partially (Sam, 2024). The prominence of specific, recalled episodes the soil lesson, the evaporation demonstration, the NECO practical aligns with DOI theory's observability attribute: teachers who can point to visible, successful outcomes of an innovation are more likely to sustain positive attitudes toward it, even amid substantial implementation barriers. Notably, one participant's divergent claim that IBL reduces teacher stress in the long run stood in tension with the majority view that IBL is time-consuming, a tension that appears linked to that same participant's unresolved fear of losing classroom control, suggesting that perceived relative advantage and perceived complexity are not independent but interact within individual teachers' overall risk calculus regarding adoption.

The barriers reported by participants overcrowded classrooms, scarce instructional materials and laboratory infrastructure, curriculum and examination time pressure and students' weak academic and socioeconomic background closely mirror recent multi-context evidence on inquiry-based science instruction. Setiyani et al. (2025) similarly identified insufficient institutional support, inadequate professional development, and time constraints as recurring, interrelated barriers to inquiry-based teaching internationally while Amie-Ogan and Oguru (2025) documented the general scarcity of STEM instructional facilities in Nigerian secondary schools. The present findings extend this literature by showing, through direct teacher testimony, how these structural conditions are experienced concretely: as forced improvisation funded from teachers' own pockets, as absent electricity precluding physics practicals and as curricula too bulky to cover using anything but lecture-based instruction under examination pressure. Within DOI theory, these accounts represent perceived complexity operating not as a fixed property of IBL itself but as an emergent property of the interaction between the innovation and severely under-resourced classroom conditions.

The case of one participant who has never attempted IBL, citing fear that a large, young class would descend into disorder, is particularly instructive. This account suggests that for at least some teachers, perceived complexity is severe enough to prevent trialability altogether the DOI attribute concerned with the degree to which an innovation can be experimented with on a limited basis. Where teachers cannot risk even a bounded trial without confidence in their classroom-management capacity, they remain, in Rogers' (2003) terms, outside the innovation-decision process entirely, a status that low-stakes, well-scaffolded professional development, of the kind teachers themselves requested, could plausibly help to address. This finding resonates with evidence from Ghanaian primary mathematics education, where teachers outside structured professional development programmes reported low self-efficacy for inquiry-oriented pedagogy despite valuing it in principle (Asante et al., 2025). Finally, teachers' recommendations for sustaining IBL structured training, material provision, financial incentives, and credible supervision map closely onto what DOI theory identifies as necessary for movement from the implementation to the confirmation stage of the innovation-decision process, at which continued use becomes routinised. Notably, one participant's account of a prior technology-distribution initiative that yielded, in her words, work that amounted to nothing due to poor targeting and weak accountability, illustrates how the credibility of the surrounding social system in this case, government and school administration shapes teachers' confidence that future interventions will translate into confirmed practice rather than symbolic, unsustained activity. This finding suggests that policy interventions intended to promote IBL in Kaduna State should attend not only to the volume of resources or training provided but to the transparency, targeting, and follow-through with which they are implemented and supervised.

6 Conclusion

This phenomenological study provided an in-depth account of how secondary school STEM teachers in Kaduna State conceptualise, value and struggle to implement inquiry-based learning. The findings confirm that teachers hold predominantly favourable, well-articulated understandings of IBL and can point to concrete, positive classroom experiences with it, yet routine and confident use remains constrained by overcrowded classrooms, inadequate instructional materials and infrastructure, curriculum and examination time pressure, students' weak academic and socioeconomic background and, for at least one teacher, an unresolved fear of losing classroom control. Interpreted through DOI theory, adoption of IBL among this group of teachers appears to be arrested primarily at the persuasion and early implementation stages, with structural and infrastructural conditions, rather than attitudinal resistance, forming the principal barrier to confirmation and sustained routine use.

These findings carry two key implications. First, Kaduna State's Ministry of Education and school leadership should prioritise structured, sustained and credibly supervised professional development for STEM teachers on IBL implementation strategies suited to large, under-resourced classrooms, rather than one-off, poorly monitored interventions of the kind one participant described. Second, curriculum planners should examine whether current STEM curricula and examination schedules leave sufficient room for inquiry-oriented activities, given teachers' consistent reports that curriculum coverage pressure discourages IBL use regardless of attitude. Investment in classroom infrastructure, instructional materials, and reliable electricity, particularly for practical-based subjects such as Physics and Chemistry, would directly address the complexity barriers most frequently cited by participants. We argue that addressing these structural conditions, rather than further attitudinal persuasion alone, is the more direct route to moving Kaduna State STEM teachers from trial to confirmed, everyday use of inquiry-based learning.

7 Limitations of the Study

This study has several limitations. First, the sample comprised seven teachers from public secondary schools in Kaduna State; while phenomenological research does not aim for statistical generalisation, this limited, single-state sample restricts the transferability of findings to private schools or other Nigerian states. Second, demographic details for some participants, notably exact years of teaching experience and specific academic qualifications, were incompletely or ambiguously stated during interviews and are reported here as given, which may limit precision in demographic interpretation. Third, as in comparable phenomenological work (Zakariya et al., 2026), the use of AI-assisted coding, though supervised through iterative human cross-validation, introduces a methodological innovation whose long-term reliability across larger qualitative datasets warrants further examination. Finally, this study did not systematically compare experiences across gender, subject specialism, or years of experience; given the apparent divergence between the one non-adopting participant and the rest of the sample, future research using larger, more diverse samples should examine such subgroup patterns explicitly.

8 Declarations

Ethical Statements: This study involved human participants (secondary school STEM teachers) and was conducted in accordance with institutional research-ethics requirements. All participants provided informed consent prior to their interviews, after being briefed on the purpose of the study, their right to withdraw at any time, and the measures taken to protect confidentiality, including pseudonymisation of transcripts.

Conflict of Interest: The authors declare neither financial nor non-financial conflict of interest.

Author Contributions: Safiya Shafiu Muhammed conceptualised the study, critically reviewed and revised the manuscript for important intellectual content, Salihu Alhassan Abdulrahman developed the interview protocol, drafted the manuscript conducted the interviews, Yusuf Feyisara Zakariya led the data analysis, contributed to the theoretical framing, supervised and cross-validated the data analysis and Ramatu Ematum Umahaba contributed to the theoretical framing and cross-validated the data analysis. All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Data Availability Statement: The interview transcripts generated and analysed for this study contain potentially identifying information and are not publicly available in order to protect participant confidentiality. De-identified data may be made available by the corresponding author upon reasonable request, subject to institutional and ethical approval.

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