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Research Article

Inquiry-based Learning in Natural Science: Teaching Performance at Saint Úrsula Catholic Affiliate Basic School Baucau, Timor-leste

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Abstract

The shift toward student-centred learning has become a global educational priority, particularly in science education, to foster critical thinking, inquiry skills, and learner autonomy. In line with this, the 2014 National Basic Education Curriculum of the Democratic Republic of Timor-Leste (RDTL) emphasizes the importance of Inquiry-Based Learning (IBL) as a core instructional method. However, many schools in the country continue to face challenges in effectively applying this approach, due to limitations in teacher preparation and professional development. This research examines how Natural Science teachers at Saint Úrsula Catholic Affiliate Basic School implement the Inquiry-Based Learning Method in their teaching practices. Specifically, the study aims to observe how these teachers integrate this method into their Natural Science classes through their instructional performance. The study involves five Natural Science teachers from the school as research participants. A qualitative descriptive approach is employed for data collection, incorporating structured individual interviews and classroom observations to gain insights into teaching practices. Aligned with the study's objectives, the research evaluates the application of the Inquiry-Based Learning Method, focusing on the extent to which it aligns with curriculum expectations and promotes active student engagement. Findings reveal that Natural Science teachers at Saint Úrsula Catholic Affiliate Basic School possess limited knowledge of the Inquiry-Based Learning Method, which poses significant challenges in effectively implementing it within their teaching practices. The results highlight a need for more targeted teacher training and support systems to bridge the gap between curriculum goals and actual classroom practice.

Keywords

Inquiry-Based Learning Method, Natural Science Teacher, Teaching Performance

1. Introduction

The primary goal of teaching is to drive profound learner transformation through effective pedagogy [15]. Educators must shift from merely transmitting knowledge to fostering learner transformation, applying efficient methodologies to elevate comprehension levels.

In the traditional era, teachers predominantly used teacher-centered methods, focusing on the teacher as the central figure in the learning process, unlike student-centered methods where learners take an active role [20]. This remains a significant challenge for educators and researchers globally.

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Addressing this issue is crucial to improving education quality, including in Timor-Leste.

In Timor-Leste, most teachers still rely on teacher-centered methods, with few adopting learner-centered or modern paradigms [39]. The 2014 Timor-Leste Education Curriculum emphasizes involving learners directly in the learning process through inquiry-based learning methodologies [31]. It also details how teachers can use local materials to engage students in Natural Science activities, reflecting Timorese experiences, culture, values, and principles.

Recent global studies highlight the positive effects of inquiry-based learning on students' scientific process skills and attitudes towards science [24]. This meta-analysis demonstrates that inquiry-based learning not only promotes scientific reasoning but also enhances students' enthusiasm for learning, making it a vital method in modern science education.

Natural science is not merely an abstract theory but a practical discipline integral to daily life [39]. Teachers should encourage active student participation in all activities to foster an active learning environment [9].

The problem or issue that the researcher aims to investigate is whether Natural Science Teachers (NST) in Timor-Leste, particularly at the Catholic Affiliate Basic School Saint Úrsula in Baucau Municipality, can effectively implement the Inquiry-Based Learning Method in the teaching process of Natural Science subjects and how it impacts their teaching performance—whether it is effective or ineffective.

Based on the illustration of this research problem, the natural science teacher is the primary human instrument in the research, so they can be identified through three categories that exist as boxes in the following categories:

1) Teachers do not know the term "Inquiry-Based Learning" and its techniques, and how to implement them in the classroom.
2) Teachers have sufficient knowledge of this methodology, but it is difficult to implement their way in the classroom.
3) Teachers know this methodology and its techniques, but refuse to change their teaching methods.

As presented in the report on "The Study of Classroom Management" in the United States of America teachers who have good teaching performance in the National School of Education engage students in all activities in the Natural Sciences class, offer self-awareness and self-ability promotion opportunities to them through study collaboration, to increase their willingness to learn and promote interpersonal relationships [35]. The evidence from other research shows that teachers with good teaching performance who know how to prepare a method of learning based on the incest in the teaching process will increase students' interest in the subject matter and other specific learning activities. Therefore, the inquiry-based learning method is a methodology that facilitates teachers to improve their teaching performance to improve and promote students' learning outcomes [16].

Previous and relevant research is of high value and can be theoretical and technical references for teachers to increase their teaching performance by promoting real and current. However, there is no local, national, or international survey on the methods of learning based on the survey that reflects the learning context in TL. Therefore, the writer conducting this research, which is appropriate to the TL context, can also be an important study and reference for all teachers in TL to promote their teaching performance through an inquiry-based learning method to build educational quality for lessons, especially the Natural Sciences class.

2. Literature Review

2.1. Definition of Inquiry-based Learning

The term 'inquiry' in English means 'to ask' or 'to investigate.' Sanjaya emphasizes that 'inquiry' is also called 'heuristic,' derived from the Greek word *heuristic*, which means 'I find' [28]. Inquiry refers to a method that emphasizes the process of critical and analytical thinking to search for and find answers to a given problem" [28].

Inquiry-based learning (IBL) is an educational strategy in which students are allowed to build scientific knowledge through practices according to the methods used by professional scientists [12]. Therefore, IBL is a new process of knowledge discovery, where the students formulate the hypothesis to be justified through experiments and observations [26].

Another sense of IBL is an approach that includes observing, examining books and other sources of information, using materials to put data together, analyzing and interpreting data, and proposing results. IBL is identified as an idea, critical, and logical view. Therefore, its explanation of the world of nature and scientific research from the results of a scientific study must be strengthened with evidence, as explained in the survey credit task graph.

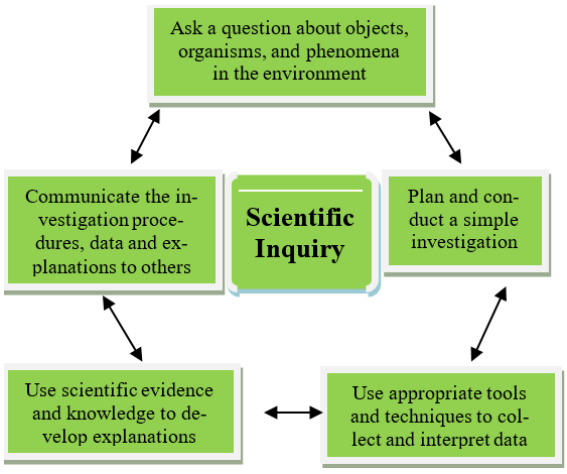

Figure 1. *Inquiry-based learning task. Adapted from Carin, Bass, and Contant, cited in Warner & Myers [44].*

2.2. Teacher Performance and Implementation of Inquiry-Based Learning Methods

Teaching involves more than just transferring science; it also facilitates students' development of their existing knowledge [36]. Inquiry-based learning places students at the center, emphasizing effective teaching and learning [29, 13]. This approach requires gathering relevant inputs to align with objectives and enhance the learning process [19].

Teaching performance is reflected in a teaching approach that combines subject mastery, student participation, classroom management, and evaluation [19]. It is influenced by factors such as teacher attitude, subject mastery, teaching methods, personal character, intellectual capacity, and positive student relationships [19]. Effective teaching performance aims to develop integrated learning objectives, fostering self-development through activities that encourage questioning, exploration, and problem-solving, promoting self-awareness and independent learning [3, 5].

2.3. Approach the Method of Learning Based on Research in the Concept of Natural Sciences

There are various learning models that teachers can use to teach subjects at school, including natural science. The objective is to facilitate the learning process to achieve specific learning objectives in each subject. In natural science, teachers are required to use an appropriate learning model that aligns with the subject content, distinct from other materials. Therefore, the Inquiry-Based Learning (IBL) model is a cognitive approach that is well-suited for natural science learning [3, 5].

Over the past decade, scientists have emphasized the importance of designing Natural Science Teaching (NST) based on investigations. According to the National Science Education Standards (NSES), the teaching plan for Natural Science involves four stages [37]:

1) Developing long-term annual plans and short-term objectives for students.
2) Selecting, adapting, and designing science curricula that align with students' interests, understanding, knowledge, capabilities, and experiences.
3) Choosing teaching strategies and academic tasks that foster students' comprehension.
4) Collaborating as partners within disciplinary areas in the classroom.

Consequently, inquiry emerges as authentic questions derived from students' experiences, serving as a central strategy in the Natural Science teaching process.

In the Timor-Leste (TL) context, the 2004 curriculum emphasizes teacher-designed lesson plans that engage students in all activities, positioning them as learning centres for competence tasks such as writing, investigation, cooperation, intervention, and information sharing [30]. Similarly, the 2014 TL Curriculum, implemented by the Ministry of Education, includes lesson plans with scientific activities that provide students with numerous opportunities to solve problems and work as scientists [39].

2.4. Implementation Stages of IBL in the Teaching Process

IBL is an educational approach that technically guides students to learn and master research competencies through observation, inquiry, description, problem formulation, hypothesis announcement, objective definition, and hypothesis verification [30]. This method can also serve as a teaching-learning model due to its clear implementation stages. Therefore, the effective implementation stages of inquiry-based learning in the classroom, as follows:

Table 1. *Steps to implement the investigation-based learning method according to Eggen & Kaucak, cited in Hendarly [17], p. 6.*

Nú.	Phases	Teachers attitude
1.	Problem-oriented	Teachers guide teachers to identify problems, and these problems are written within the framework. Teachers share the teachers with the group.
2.	The formulation of the hypothesis	The teacher allows students to share ideas in the form of a hypothesis (the probability of the problem). The teacher guides the students to decide which hypothesis is relevant to the problem and prioritizes which hypothesis is a priority for investigation.
3.	Projecting the experiments	The teacher allows students to determine the steps that are adjusted or appropriate to the hypothesis to be executed. The teacher guides the students to classify the stages of the experiment.
4.	Carry out the data/information process	The teacher guides students to obtain information through experience.
5.	Data collection and analysis	The teacher allows each group to communicate or report the data processing results collected.
6.	Draw conclusions	The teacher guides students to solve problems.

The stages of inquiry-based learning guide students to find solutions to problems through orientation, problem formulation, hypothesis announcement, data collection, hypothesis

experimentation, and conclusion formulation [17], as outlined in Table 2.

Table 2. *Implementation Phases of IBL as per Sanjaya, cited in Hendarly [17], p. 7.*

No.	Phase	Teacher Activities
1	Orientation	The teacher elucidates the topic, objectives, and potential outcomes of the study that students can attain. Describes the key aspects of the activity that require student engagement to achieve the objectives. Also outlines the stages of inquiry.
2	Problem Formulation	The teacher introduces students to concepts containing problems and motivates them to seek answers. The problems presented should be clear, solvable, and contain relevant concepts.
3	Hypothesis Generation	The teacher motivates students to formulate hypotheses through guiding questions that facilitate provisional responses.
4	Data Collection	The teacher encourages students to gather necessary information through experimentation. Students design, conduct experiments, and collect data under guidance.
5	Hypothesis Testing	The teacher guides students to analyze experimental data and test the hypotheses they previously formulated before concluding.
6	Conclusion Formulation	The teacher guides students to conclude from the analyzed experimental data. Subsequently, presents these conclusions in class discussions

2.5. Implementing Systematic Methodologies in Natural Science Classrooms

The effective implementation of systematic methodologies in educational settings necessitates high levels of teaching performance, a crucial factor in the development of educational policies [7]. According to Colburn, for the successful integration of inquiry-based learning (IBL) in Natural Science classrooms, teachers should adhere to specific strategies. These include:

Asking open-ended, or divergent, questions (such as "What are you doing?" "Tell me about what you're thinking?" and "What do you think would happen if…?"); Waiting a few seconds after asking the questions, giving student time to think; Responding to students by repeating and paraphrasing what they have said without praising or criticizing (to encourages students to think for themselves, and to stop looking to the teacher for validation); Avoiding telling students what to do, praising, evaluating, rejecting, or discouraging student ideas and behaviors; and Maintaining a disciplined classroom [7].

Research indicates that the questions or problems presented in inquiry-based learning should act as obstacles and challenges, encouraging students to critically evaluate existing knowledge and independently respond to problems [38]. This approach stimulates critical thinking and fosters self-directed problem-solving among students.

In this way, Teachers require routine and effective interactions with students, providing maximum assistance throughout the learning process. By adopting this approach, teachers can discover how to support and motivate students to actively participate in the learning process [19]. This method helps students develop self-confidence and enhances their self-understanding, thereby facilitating the achievement of learning objectives [32, 33, 43].

2.6. Barriers to Implementing Inquiry-Based Learning in Science Classes

Inquiry-based learning is a crucial approach in science classes, as its objectives and functions aim to encourage students to take an active role in acquiring a sense of learning in these settings [43]. However, this approach poses challenges for teachers who utilize it in science classes. Some teachers are perplexed by this approach due to their limited mastery of subject, teaching methods, personal characteristics, intellectual capacity, and personality; and there exists a pessimistic perception that inquiry-based learning is a method that can only be employed for students with high academic abilities [19, 23]. These challenges arise because teachers lack adequate preparation and professional development capacity to implement inquiry-based learning [6, 7, 43].

In the context of learning in Timor-Leste, many teachers believe they are the center of the learning process. Significantly, his research illustrates that only four out of forty-two teachers provided opportunities for students to express their opinions or ask questions [39]. This phenomenon can be described as a difficulty for teachers to implement inquiry-based learning in science classes, as many adhere to traditional teaching methods [23, 39] and hold the philosophical view that teaching and learning are a matter of copying and pasting, where students cannot study beyond what the teacher transmits [23, 39].

2.7. Change Management

Effective change management in educational settings requires a strategic approach that aligns with contemporary pedagogical practices. Recent studies highlight the importance of integrating technology to enhance classroom effectiveness [45]. For instance, digital tools can facilitate

personalized learning experiences, which are crucial for improving student outcomes. The Prosci ADKAR Model provides a framework for managing change by focusing on awareness, desire, knowledge, ability, and reinforcement. This model is particularly relevant in educational contexts where teachers need to adapt to new technologies and methodologies.

Professional development is a critical component of successful change management in education. Centers for Teaching and Learning (CTLs) play a pivotal role in supporting educators through evidence-based training and workshops. These programs not only enhance teachers' technical skills but also foster a collaborative environment where educators can share best practices. The emphasis on peer-led initiatives and hands-on training aligns with the findings of Connolly & Seymour [8], who suggest that such approaches are effective in encouraging teachers to adopt new methods. Moreover, long-term professional development programs are essential for sustaining improvements in teaching practices.

Collaborative strategies such as peer review, mentoring, and study groups are increasingly recognized as effective tools for teacher professional development. These activities promote a culture of continuous improvement by encouraging teachers to learn from each other and adapt to changing educational landscapes. The Nudge Theory, which emphasizes subtle guidance and indirect suggestions, can also be applied to encourage teachers to adopt new practices without feeling coerced [8]. By creating supportive environments where teachers feel empowered to innovate, educational institutions can foster a culture of innovation and excellence.

The ultimate goal of change management in education is to create a dynamic learning community that engages students actively in their learning process. This can be achieved by adopting innovative teaching methods that leverage technology and collaborative learning strategies [21]. For instance, reciprocal teaching methods not only enhance student participation but also promote critical thinking skills. The ADKAR Model supports this approach by emphasizing the importance of creating an inclusive environment where students feel empowered to share ideas collaboratively. Such learning communities not only improve student outcomes but also provide a supportive framework for teachers navigating changes in instructional practices.

2.8. Strategic Models for Inquiry-Based Learning: Emphasizing Effective Instruction in Natural Science Classes

Various strategic models can be employed to achieve the objectives of inquiry-based learning. One such model is the instructional 5-E model, which includes Engagement, Exploration, Explanation, Elaboration, and Evaluation [1].

The 5-E instructional model is an effective approach to facilitating inquiry-based learning. Consequently, the National Research Council (NRC) asserts that inquiry-based learning is an instrumental tool for developing higher-order thinking skills in scientific work activities [1]. The function of inquiry-based learning models is to develop intellectual abilities, critical thinking, and the capacity to solve problems scientifically [1]. This emphasizes intellectual capacity and personal development (Ishak & Rusman, 2018), guiding students into the world of scientific inquiry [4].

The NRC highlights that scientific inquiry helps students develop an understanding of scientific concepts; appreciation for scientific understanding in science; comprehension of the nature of science; necessary skills for inquiring about the natural world; and the rules for using skills and attitudes associated with science [4]. Therefore, scientific inquiry is crucial to implement through the 5-E instructional model to have a positive impact on the implementation of inquiry-based learning methods in natural science classes.

Table 3. *Orientation to the achievement of ABI with the 4E1A strategy by Abustaco & DeRosa, located in Asna [1], p. 156.*

Phase	Orientation	Objectives
Engagement	1) Create unique experiences 2) Motivate students to recall prior knowledge 3) Encourage reflection on existing knowledge 4) Ask questions 5) Listen actively	1) Develop conceptual models 2) Understand prior knowledge 3) Generate or produce questions
Exploration	1) Align student experiences to acquire new and deeper knowledge 2) Ask questions 3) Practice skills	1) Gain a deeper understanding 2) Conduct experiments 3) Discover new knowledge through observation and manipulation 4) Make connections 5) Manage, produce, collect, and record data
Explanation	1) Revisit key questions	1) Produce models capable of clear explanations.

Phase	Orientation	Objectives
	2) Facilitate responses from students 3) Strengthen correct answers 4) Correct misconceptions	2) Answer key questions effectively 3) Address misconceptions
Elaboration	Create challenging tasks for students to apply and transfer newly acquired knowledge	1) Reinforce explanations. 2) Apply knowledge in different contexts
Evaluation	1) Provide feedback from students 2) Identify references to measure student progress 3) Modify materials based on feedback 4) Conduct summative assessments to evaluate learning	Demonstrate mastery of new knowledge in nominal, descriptive, and clear comprehension stages

2.9. Positive Impact of the Implementation of the Inquiry-based Learning Method: Teacher Teaching Performance

The IBL method is a fundamental teaching and learning approach in natural science classes. It supports natural science teachers by enhancing their professional development through capacity building in effective strategies and methodologies to improve teaching delivery [24]. Research indicates that implementing the IBL method fosters teachers' intellectual and personal capacities, empowering them to be creative, positive, and independent in their teaching practices [14].

Recent studies emphasize that IBL promotes higher levels of student engagement and learning outcomes due to its student-centred approach. This method allows students to explore scientific concepts through active participation, critical thinking, and problem-solving [4, 18]. Teachers who effectively implement IBL can guide students in developing scientific reasoning and communication skills while fostering curiosity and autonomy [14].

Teachers who master the IBL method can elevate students' skills and knowledge beyond traditional methodologies [32]. Similarly, recent research underscores the importance of qualified teachers in primary education who can deliver clear concepts and procedures using IBL methods [41]. Teachers must adapt the IBL approach to suit different educational levels, as it is particularly effective for promoting advanced learning outcomes in natural science education [14].

In natural science classrooms, implementing IBL benefits students across all age groups by improving their learning performance through high-quality teaching [33]. Evidence shows that teachers with strong performance in IBL can significantly enhance students' interest in specific disciplines and activities while increasing their knowledge and understanding.

The IBL method engages students by encouraging exploration of the curriculum and fostering curiosity. When teachers use this approach effectively, it strengthens teacher-student relationships and promotes a comprehensive understanding of scientific content and processes [18]. This method also stimulates critical thinking among students and helps them become independent learners who actively participate in the learning process [14, 22]. Consequently, students perform better when teachers align instructional strategies with learning objectives to ensure quality educational outcomes.

3. Research Method

The researcher employed a qualitative research method in this study, aiming to explore, develop, and validate scientific phenomena through interviews, observations, and documentation. This approach is widely recognized for its ability to provide rich, descriptive data by focusing on lived experiences and contextual insights [11]. The qualitative research design employed in this study follows best practices outlined by Mutch [34], who emphasizes the importance of understanding participant perspectives and educational context through interviews and observations. Specifically, the researcher utilized two qualitative research instruments with five natural science teachers at Saint Úrsula Catholic Affiliate Basic School.

The first instrument was a structured individual interview format based on pre-prepared questions. This method allowed for in-depth exploration of participants' perspectives and experiences [11]. The second instrument involved non-participant observation, where the researcher systematically recorded detailed accounts of observed events without direct involvement. This method is effective in capturing authentic behaviors and interactions within natural settings [10]. Together, these instruments provided comprehensive insights into teaching practices and the implementation of inquiry-based learning methods.

The qualitative research interview consisted of ten structured questions (see Table 4) designed to gather data through a conversational process. This approach aimed to construct knowledge on the specific research topic of teaching perfor-

mance among natural science teachers who implement inquiry-based learning at Saint Úrsula Catholic Affiliate Basic School Baucau [11]. The interview sought to explore how teachers' use of inquiry-based learning impacts their teaching performance and to approach research findings related to this phenomenon.

In addition to interviews, the researcher employed a qualitative non-participant observation instrument (see Table 4) to examine the implementation of the inquiry-based learning method by five natural science teachers at the same school. This observation aimed to assess teachers' teaching performance in natural science classes based on conceptual values reflected in their attitudes, speech, and writing [10]. The observation focused on seven key issues related to the implementation of inquiry-based learning by these teachers (see Table 4). By analyzing these observations, the researcher sought to verify the concept of teaching performance in natural science classes through the values expressed in teachers' attitudes, words, and writing [10].

Table 4. *Observations & Interview Questions for Teachers Regarding the Implementation of Inquiry-Based Learning Methods in Natural Science Classes.*

No.	Observation Focus	No.	Interview Questions
1	Implementation of IBL in Natural Science teaching	1	What are your thoughts on the Inquiry-Based Learning (IBL) method?
2	Student engagement in learning activities	2	How do you incorporate IBL into your teaching practices?
3	Impact of IBL on students' personality (active, creative, responsible)	3	Do students show enthusiasm and enjoyment when you use this method in teaching? Why?
4	Teachers fostering students' happiness and enthusiasm with IBL	4	In your science lessons, do you engage students in all activities? How?
5	Effectiveness of teachers' instructional methods using IBL	5	Does IBL make students more active, creative, and responsible for their studies? Why?
6	Impact of IBL on Natural Science learning objectives	6	Is IBL the most effective method used by teachers to teach science? Why?
		7	How do you assess students' understanding of the subject content when using IBL in science teaching?
		8	When you use IBL, does it support you and your students in achieving learning objectives? Why?
7	Challenges faced by teachers in implementing IBL	9	What difficulties do you encounter when implementing this method in science lessons?
		10	What improvements do you think are needed to enhance the implementation of this method in the teaching process?

The main participants in this research were teachers who taught natural science at Saint Úrsula Catholic Affiliate Basic School, Baucau. Out of a total of ten teachers, five were selected as research samples using purposive sampling. Purposive sampling, also known as judgmental or selective sampling, is a non-probabilistic technique that involves deliberately choosing participants based on specific characteristics relevant to the research objectives [2, 40]. This method allows researchers to focus on information-rich cases that provide deep insights into the phenomenon being studied.

In this study, the researcher collaborated with the school coordinator to select participants. The school coordinator identified five teachers who met the criteria for the study and provided their names to the researcher. Subsequently, research activities were conducted with these participants in their respective classrooms to examine their teaching performance and implementation of inquiry-based learning methods.

4. Justification of Research Results

The contemporary world of education necessitates that Natural Science Teachers (NSTs) implement teaching strategies that cultivate 21st-century competencies, such as active learning, creativity, critical thinking, collaboration, and innovation [42], thereby enhancing their teaching performance [25]. The inquiry-based learning (IBL) strategy presents an alternative methodology to achieve these competencies, requiring NSTs to implement high-quality IBL strategies that

facilitate effective, accurate, and engaging learning experiences in natural science classes.

Based on the overarching hypothesis, teachers can be classified into three distinct categories: (1) NSTs unfamiliar with IBL principles and their classroom application, (2) those aware of IBL as an instructional technique but struggling with its effective implementation, and (3) those knowledgeable about IBL methodologies but resistant to altering their established teaching practices.

Evidence obtained from interview data suggests that NSTs generally possess adequate theoretical knowledge regarding the inquiry-based learning approach. However, its practical implementation in their natural science lessons remains limited. The integration of IBL methods can either support or challenge teachers. This difficulty in implementation extends to various aspects of learning activities, which involve making observations, posing questions, consulting learning resources, planning investigations, re-experimenting with new ideas, and collecting additional evidence through hands-on experimentation, data analysis, interpretation, and prediction—all of which contribute to meaningful discussions [27]. Despite these recognized benefits, research findings indicate that teachers have not consistently adopted the most effective investigation-based learning approaches in their classrooms.

Qualitative observations reveal that teachers cultivate a positive classroom atmosphere to foster student engagement and enthusiasm in natural science lessons. NSTs adhere to the new Natural Sciences Learning Plan, enabling them to conduct lessons effectively. Concurrently, participants utilize the plan during observational research for lesson enactments, experiments, discussions, and presentations.

The reported learning strategy within the Natural Sciences Learning Plan is broad and lacks specific guidance on the technical implementation of particular teaching methods, including IBL. While NSTs facilitate basic problem-solving activities in small groups, guide students through experiments, and assist them in presenting their results to larger groups, they often neglect to encourage students to independently formulate hypotheses as potential solutions to problems. Additionally, students often lack opportunities to rigorously test their hypotheses or draw their own evidence-based conclusions. This implies that the full inquiry-based learning process is not consistently applied in natural science instruction.

In alignment with the National Curriculum of Basic Education (First and Second Cycles, 2014) emphasis is placed on student-centred learning through structured activities. However, a key concern for NSTs is that these activities are not always effectively integrated with IBL methodologies. While the curriculum may reference IBL, it does not clearly articulate the specific stages necessary for its effective implementation. This discrepancy can negatively impact the teaching performance of natural science educators.

Concerning the three hypotheses outlined earlier, the research findings align most closely with the second hypothesis: NSTs possess adequate theoretical knowledge of IBL but encounter challenges in its application within their classrooms. Furthermore, the study highlights areas for improvement in NSTs' teaching performance, including their attitudes, subject mastery, teaching strategies, personal characteristics, intellectual capacity, and professional relationships. Given these findings, it is recommended that NSTs at Saint Úrsula Catholic Affiliate Basic School receive specialized training in IBL methods. This training would enhance their understanding of inquiry-based teaching strategies, ultimately improving the quality and effectiveness of their natural science lessons.

5. Conclusion

This research investigated the implementation of inquiry-based learning (IBL) by Natural Science Teachers (NSTs) at Saint Úrsula Catholic Affiliate Basic School, revealing a critical gap between theoretical understanding and practical application. While NSTs demonstrate familiarity with IBL principles, several key factors hinder its effective integration into their classrooms. Addressing this gap is essential to fostering student engagement, promoting deeper understanding of scientific concepts, and enhancing the overall quality of natural science education at the school.

Firstly, the study revealed that the Natural Sciences Learning Plan, while providing a general framework, lacks explicit guidance on the specific stages and techniques of IBL implementation. This ambiguity leaves NSTs without clear direction on how to translate IBL theory into actionable classroom practices. As evidenced by classroom observations, NSTs tend to rely on traditional methods such as basic problem-solving activities and experiment demonstrations, which often fall short of fostering genuine inquiry skills. Secondly, a significant finding was the limited emphasis on student-led hypothesis formulation and testing. Although the National Curriculum of Basic Education 2014 promotes student-centered learning, the research indicates that NSTs often do not provide students with adequate opportunities to independently develop and test their hypotheses. This omission undermines a core tenet of IBL, which emphasizes student agency and critical thinking. Thirdly, the study identified a need for enhanced pedagogical content knowledge among NSTs.

In light of these findings, it is recommended that Saint Úrsula Catholic Affiliate Basic School prioritize the following actions: (1) Provide targeted professional development for NSTs on IBL implementation, focusing on practical strategies for designing and facilitating inquiry-based lessons, incorporating student-led investigations, and aligning IBL activities with curriculum standards. (2) Revise the Natural Sciences Learning Plan to include explicit guidance on IBL implementation, providing clear examples of IBL activities, assessment strategies, and resources to support NSTs in their efforts. (3) Create opportunities for students to engage in authentic inquiry-based projects, encouraging them to formulate their own research questions, design investigations,

collect and analyze data, and draw evidence-based conclusions.

By addressing these challenges and implementing these recommendations, Saint Úrsula Catholic Affiliate Basic School can empower its NSTs to create more engaging, effective, and inquiry-driven learning experiences, thereby cultivating essential 21st-century competencies among its students. This, in turn, will contribute to a more robust and dynamic natural science education program that prepares students to become critical thinkers, problem-solvers, and lifelong learners.

6. Recommendations

Based on the finding that Natural Science Teachers (NSTs) at Saint Úrsula Catholic Affiliate Basic School need a deeper understanding and effective application of Inquiry-Based Learning (IBL), the following steps are recommended:

To address the current reliance on traditional methods, it is recommended that NSTs at Saint Úrsula Catholic Affiliate Basic School intentionally integrate specific IBL techniques that actively cultivate students' abilities to think and work independently. This includes explicit instruction in hypothesis formulation, guiding students in structured experiment design activities, and facilitating data interpretation and evidence-based reasoning.

To address the identified gap in pedagogical content knowledge, Saint Úrsula Catholic Affiliate Basic School should actively encourage NSTs to engage in ongoing professional development focused on IBL. This includes dedicated IBL workshops and training sessions, collaborative lesson planning and peer observation, and access to online resources and professional networks related to IBL.

For specialized, hands-on IBL training, Saint Úrsula Catholic Affiliate Basic School should seek partnerships with NGOs where experts in IBL can collaborate with the Ministry of Education. This collaboration should focus on practical IBL training for NSTs, mentorship and coaching support, and the development of contextually relevant IBL resources and materials.

To facilitate the systematic and effective application of IBL in natural science classes, the Ministry of Education should lead a review of the 2014 National Basic Education Curriculum I & II, ensuring that the curriculum clearly articulates the principles of IBL and provides specific guidance on integrating IBL activities into lessons, offering examples of IBL-based assessments, and training teachers for an efficient learning.

Abbreviations

5-E	Engagement, Exploration, Explanation, Elaboration, and Evaluation
ADKAR	Awareness, Desire, Knowledge, Ability, Reinforcement
IBL	Inquiry-Based Learning
CTLs	Centers for Teaching and Learning
NGOs	Non-Governmental Organizations
NRC	National Research Council
NSTs	Natural Science Teachers
NSES	National Science Education Standards
TL	Timor-Leste

Author Contributions

João Mariano Helder de Deus is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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