

Implementation and Perceived Effectiveness of Inquiry-Based Learning Strategies in Science

Shaira May M. Goriona

Master of Arts in Education, Major in Science, University of Perpetual Help System DALTA, Las Piñas City, Philippines

Email of Corresponding Author: gorionashairamay@gmail.com

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Abstract

This study examined the implementation and perceived effectiveness of Inquiry-Based Learning (IBL) strategies in science among teachers and students in five public junior high schools in Panabo City, Davao del Norte. Anchored in Constructivist Learning Theory, Social Constructivism, Progressive Inquiry, and Cognitive Load Theory, it employed a quantitative descriptive-correlational design. Respondents comprised 31 Science teachers selected through total enumeration and 100 Grade 10 students selected through purposive sampling. Data were collected using validated researcher-developed questionnaires and analyzed using descriptive statistics, Pearson correlation, and independent samples t-tests. Teachers rated IBL implementation as Highly Implemented ($M = 4.66$) and its effectiveness as Highly Effective ($M = 4.71$), whereas students rated implementation as Implemented ($M = 4.17$) and effectiveness as Effective ($M = 4.09$). Significant positive relationships emerged between implementation and perceived effectiveness, with stronger associations in students' assessments. Significant differences between teacher and student ratings indicated disparities in their classroom perceptions. The findings concerned student engagement, conceptual understanding, scientific inquiry skills, collaborative learning, and problem-solving abilities. The study proposed the INQUIRE+ Professional Development Program to strengthen Science teachers' inquiry-based instruction through coaching, collaborative lesson study, reflective practice, and systematic monitoring and evaluation. It aligns with Sustainable Development Goal 4 (Quality Education) by supporting improved Science instruction and continuing teacher development. Its contribution to educational and institutional sustainability lies in promoting sustained professional learning, school-based collaboration, and evidence-informed instructional improvement across participating schools and varied local classroom learning contexts. Further evaluation of the proposed program is needed to establish its effectiveness after implementation.

Keywords: Collaborative Learning, Conceptual Understanding, Inquiry-Based Learning, Instructional Effectiveness, Professional Development, Science Education, Scientific Inquiry Skills, Student Engagement, Teacher Perceptions

1. Introduction

Inquiry-Based Learning has become an important instructional strategy for developing scientific literacy and higher-order thinking skills. Through investigation, evidence-based reasoning, and reflection, students actively participate in constructing scientific knowledge instead of relying exclusively on direct instruction (Talavera-Mendoza et al., 2024). In the Philippines, science education continues to face significant challenges. Results from the Trends in International Mathematics and Science Study (TIMSS) 2019 indicated that only 19% of Filipino students reached at least the Low international benchmark in science, reflecting difficulties in foundational

scientific knowledge and conceptual understanding (Bernardo et al., 2023). These findings emphasize the need for instructional approaches that strengthen students' scientific reasoning and learning experiences. Research supports the potential of IBL to address these challenges. A meta-analysis reported a large positive effect on higher-order thinking skills ($g = 0.893$) (Antonio & Prudente, 2024), while another identified substantial improvement in conceptual understanding ($g = 0.913$), particularly through open inquiry (Mediana et al., 2025). However, implementing IBL requires appropriate instructional guidance, teacher competence, and student readiness. In the researcher's classroom context, students accustomed to teacher-directed instruction sometimes experience difficulty with independent questioning, investigation, and problem-solving. These challenges demonstrate the importance of examining how teachers implement inquiry strategies and how students perceive their effectiveness.

The reviewed literature identifies three major areas influencing inquiry-based science education: instructional approaches, perceived learning effectiveness, and teacher professional development. Inquiry-based instruction generally involves structured, guided, and open inquiry. Structured inquiry provides greater teacher direction, guided inquiry combines instructional support with student investigation, and open inquiry offers greater learner independence. The appropriateness of each approach depends on students' prior knowledge, readiness, and available instructional support (Owolade et al., 2022; Wang et al., 2022). Studies consistently associate IBL with improvements in conceptual understanding, scientific inquiry skills, and higher-order thinking. However, effective implementation requires appropriate scaffolding, clear learning objectives, and opportunities for students to connect evidence with scientific explanations (Antonio & Prudente, 2024; Urdanivia Alarcon et al., 2023). Student engagement is another important dimension. Inquiry activities connected to meaningful questions and real-life experiences encourage behavioral, emotional, and cognitive participation. Collaborative investigations also develop communication, evidence evaluation, and shared problem-solving skills (Sam, 2024; Talavera-Mendoza et al., 2024). The literature further emphasizes that guided inquiry can strengthen scientific process skills and conceptual comprehension, particularly when teachers provide structured support and formative feedback (Aregehagn, 2022; Sulistyani, 2022). Digital learning resources, including virtual laboratories and simulations, can support inquiry activities, although their effectiveness depends on teachers' ability to integrate technology with appropriate instructional methods (de Jong et al., 2024; Ormanci, 2025). Teacher professional development is essential for sustaining effective IBL implementation. Programs involving instructional coaching, collaborative lesson planning, classroom observation, and reflective practice provide more consistent support than isolated training sessions (Aguila, 2023; Strat et al., 2024). Context-sensitive professional development also helps teachers address classroom constraints while strengthening instructional competence (Talavera-Mendoza et al., 2024). Overall, the literature suggests that the effectiveness of IBL depends not only on the inquiry strategy selected but also on teacher preparation, instructional guidance, student participation, and institutional support.

At the global level, inquiry-based science education is recognized for promoting active learning, conceptual understanding, and scientific reasoning. Research syntheses indicate that inquiry-based approaches can improve higher-order thinking and conceptual learning, especially when supported by appropriate instructional guidance (Antonio & Prudente, 2024; Mediana et al., 2025). At the national level, the Philippines continues to address challenges in science achievement and instructional quality. The country's performance in international assessments highlights the importance of strengthening scientific literacy and improving classroom teaching approaches (Bernardo et al., 2023). Philippine research also identifies limited resources, curriculum demands, teacher preparation, and varying levels of institutional support as factors affecting inquiry-based instruction (Aguila, 2023; Talavera-Mendoza et al., 2024). At the local level, the study focused on five selected public junior high schools in the Division of Panabo City, Davao del Norte. Science teachers and Grade 10 students provided assessments of the implementation and perceived effectiveness of structured, guided, and open inquiry strategies. The researcher's classroom observations indicated that some students remained dependent on direct explanations and experienced difficulties with independent investigations. These circumstances demonstrate the need for locally grounded evidence that considers both teacher and student perspectives. Understanding their experiences can support the development of instructional practices and professional learning activities suited to the realities of public-school science education.

The study was anchored in Constructivist Learning Theory, Social Constructivism, Progressive Inquiry or Knowledge-Building Theory, and Cognitive Load Theory. Constructivist Learning Theory explains that students develop understanding by connecting new experiences with existing knowledge. Within IBL, teachers facilitate exploration, questioning, and reflection, allowing learners to construct scientific concepts through active participation (Zhu & Atompag, 2023). Social Constructivism emphasizes the importance of social interaction, collaboration, and instructional scaffolding in knowledge development. Learning occurs through interaction with others and guided participation, providing a theoretical foundation for collaborative investigations in science classrooms (Vygotsky, 1978). This perspective supports the investigative and reflective characteristics of inquiry-based instruction (Bereiter & Scardamalia, 1993). Cognitive Load Theory emphasizes the limitations of working memory and the importance of appropriate instructional guidance. Excessively independent inquiry may overwhelm learners, while structured support can help them manage complex learning activities and gradually develop independence (Sweller, 2022). The study also employed the Input–Process–Output (IPO) model as its conceptual framework. Inputs included teacher demographic characteristics, the extent of implementation of structured, guided, and open inquiry, and perceived effectiveness in student engagement, conceptual

understanding, scientific inquiry skills, collaborative learning, and problem-solving. The process involved collecting and analyzing teacher and student assessments through descriptive and inferential statistical procedures. The output was a proposed professional development program designed to strengthen science teachers' implementation of inquiry-based learning strategies.

Although existing studies demonstrate the benefits of IBL, much of the literature emphasizes student achievement, conceptual understanding, and higher-order thinking rather than comparing teachers' and students' perceptions of actual classroom implementation. Research also indicates that instructional outcomes depend on the quality of scaffolding, teacher competence, and contextual conditions (Antonio & Prudente, 2024; Urdanivia Alarcon et al., 2023; Wang et al., 2022). Implementation challenges remain significant, including limited instructional materials, large classes, assessment pressures, and insufficient professional development opportunities. These conditions may influence teachers' selection of inquiry strategies and students' experiences of investigative learning (Aguila, 2023; de Jong et al., 2024; Talavera-Mendoza et al., 2024). Furthermore, professional development programs are more sustainable when they respond to actual instructional needs rather than relying exclusively on generalized training approaches (Aguila, 2023; Strat et al., 2024). The present study addressed these gaps by examining the implementation and perceived effectiveness of structured, guided, and open inquiry strategies from the perspectives of science teachers and Grade 10 students. It investigated the relationship between implementation and perceived effectiveness, identified differences between respondent groups, and used the findings to develop a professional development program responsive to local instructional conditions.

The study primarily aligns with Sustainable Development Goal 4 (SDG 4): Quality Education, which promotes inclusive, equitable, and quality education and lifelong learning opportunities. By examining inquiry-based science instruction, the research supports efforts to improve teaching practices, strengthen scientific literacy, and develop students' critical thinking and problem-solving abilities. Its emphasis on teacher professional development also contributes to improving instructional competence and educational quality. The study also relates to SDG 9: Industry, Innovation and Infrastructure, particularly its emphasis on innovation and the development of scientific and technological capabilities. Inquiry-based learning encourages investigation, evidence-based reasoning, and creative problem-solving, which are important foundations for scientific and technological innovation. The literature also identifies digital simulations and virtual laboratories as resources that can support inquiry-based science instruction when appropriately integrated into teaching (de Jong et al., 2024; Ormanci, 2025). Additionally, the study has relevance to SDG 17: Partnerships for the Goals through its emphasis on collaboration among teachers, school administrators, and educational stakeholders. Professional learning communities, instructional coaching, and collaborative lesson planning can support the continuous improvement of science teaching practices (Aguila, 2023; Strat et al., 2024). These connections reflect the study's potential contribution to educational quality, scientific innovation, and collaborative professional learning rather than direct measurement of SDG outcomes.

The study contributes primarily to educational, institutional, social, and scientific sustainability by examining how inquiry-based learning can support effective and continuing improvements in science education. From an educational sustainability perspective, the study emphasizes instructional approaches that promote scientific literacy, conceptual understanding, critical thinking, and independent problem-solving. Inquiry-based learning encourages students to participate actively in constructing knowledge and developing competencies applicable beyond the classroom (Antonio & Prudente, 2024; Mediana et al., 2025). In terms of institutional sustainability, the research provides a basis for strengthening science teachers' professional competencies through continuous training, collaborative planning, instructional coaching, and reflective practice. Sustained professional development can support consistent instructional improvement and help schools respond to changing educational needs (Aguila, 2023; Strat et al., 2024). Regarding social sustainability, the study recognizes the importance of inclusive and collaborative learning environments. Appropriate scaffolding and differentiated inquiry strategies can help students with varying levels of readiness participate meaningfully in scientific investigations. These approaches may support more equitable learning opportunities when teachers consider students' abilities and classroom circumstances (Mediana et al., 2025; Talavera-Mendoza et al., 2024). The study also supports scientific and technological sustainability by emphasizing inquiry skills, evidence-based reasoning, and the appropriate integration of digital learning resources. Technology-supported inquiry can expand opportunities for scientific investigation, particularly in classrooms with limited physical laboratory resources (de Jong et al., 2024; Ormanci, 2025). Overall, the study contributes to multidisciplinary sustainability by providing locally grounded evidence for improving science instruction, supporting teacher professional growth, encouraging inclusive learning, and strengthening institutional capacity. Its proposed professional development program offers a practical foundation for sustaining inquiry-based teaching practices in the selected public junior high schools in the Division of Panabo City, Davao del Norte.

2. Material and methods

2.1 Research Design

The study utilized a quantitative descriptive-correlational research design to examine the implementation and perceived effectiveness of Inquiry-Based Learning strategies in science education. The descriptive component assessed the extent of implementation of structured, guided, and open inquiry and their perceived effectiveness in

enhancing student engagement, conceptual understanding, scientific inquiry skills, collaborative learning, and problem-solving abilities. The correlational component determined the relationship between the extent of implementation and perceived effectiveness, while comparative analysis identified differences between teachers' and students' assessments. This design provided measurable evidence to support the development of a professional development program aimed at strengthening Science teachers' implementation of IBL strategies.

2.2 Locale of the Study

The study was conducted in five selected public junior high schools under the Schools Division of Panabo City, Davao del Norte, Philippines. These schools were Kauswagan National High School, San Vicente National High School, Little Panay National High School, A.O. Floirendo National High School, and Cagangohan National High School. The selected schools served as the research setting for assessing the implementation and perceived effectiveness of Inquiry-Based Learning strategies among science teachers and Grade 10 students.

2.3 Respondents of the Study

The respondents consisted of 31 Science teachers handling Grades 7 to 10 and 100 Grade 10 students from the five participating public junior high schools. Teacher-respondents were required to be currently teaching Science at the junior high school level, have at least one year of teaching experience in their respective schools, and voluntarily provide informed consent. Student-respondents were officially enrolled in Grade 10 during the school year of the study, had completed the Science curriculum from Grades 7 to 10 as specified in the manuscript, and voluntarily agreed to participate. Both groups provided assessments of the implementation and perceived effectiveness of IBL strategies based on their classroom experiences.

2.4 Sample and Sampling Procedure

The study employed total enumeration for science teachers and purposive sampling for Grade 10 students. All 31 eligible Science teachers from the five selected schools participated, comprising six teachers from Kauswagan National High School, nine from San Vicente National High School, four from Little Panay National High School, eight from A.O. Floirendo National High School, and four from Cagangohan National High School. Total enumeration was used because the teacher population was manageable and allowed comprehensive representation of eligible teachers in the participating schools. For student-respondents, purposive sampling was applied to select 20 Grade 10 students from each school, resulting in 100 participants. Grade 10 students were selected because their exposure to junior high school Science instruction enabled them to provide informed assessments of inquiry-based teaching strategies. The combined sample consisted of 131 respondents.

2.5 Research Instrument

The study utilized standard and researcher-developed questionnaires to collect data on the implementation and perceived effectiveness of Inquiry-Based Learning strategies. The instrument consisted of two main parts. The first measured the implementation of structured, guided, and open inquiry, with five items for each category developed from related literature (Antonio & Prudente, 2024; Wang et al., 2022). The second assessed perceived effectiveness in enhancing student engagement, promoting conceptual understanding, developing scientific inquiry skills, encouraging collaborative learning, and improving problem-solving abilities, with five items for each dimension (Mediana et al., 2025; Urdanivia Alarcon et al., 2023). A five-point Likert scale was used to measure respondents' assessments, with corresponding mean ranges and verbal interpretations. The questionnaire underwent content validation by experts in science education and research methodology, who evaluated its clarity, relevance, and alignment with the study objectives. Pilot testing was conducted among science teachers and students outside the main study population to assess comprehensibility and reliability. Internal consistency was evaluated using Cronbach's alpha, with a coefficient of 0.70 or higher considered acceptable. Feedback from the validation and pilot testing was used to refine the instrument before administration.

2.6 Data Gathering Procedure

Before data collection, the researcher obtained formal approval from the Schools Division Office of Panabo City and secured permission from the principals of the five participating schools. Written informed consent was obtained from science teachers, while parental consent and student assent were secured for Grade 10 participants. The researcher then administered the validated questionnaires to the respondents following standardized instructions. Student questionnaires were distributed during science classes under the supervision of the researcher or assigned teachers, while teacher questionnaires were administered personally or through an online platform, depending on availability. Respondents were instructed to answer independently and honestly based on their experiences with Inquiry-Based Learning strategies. Completed questionnaires were collected, checked, organized, and encoded for statistical analysis. Confidentiality and voluntary participation were maintained throughout the data-gathering process.

2.7 Data Analysis Techniques

The collected data were analyzed using descriptive and inferential statistical methods. Frequency and percentage were used to describe the demographic profiles of teacher-respondents. Mean and standard deviation were

employed to determine the extent of implementation and perceived effectiveness of Inquiry-Based Learning strategies and to describe variations in teachers' and students' responses. Pearson's Product-Moment Correlation Coefficient (r) was used to determine the strength and direction of the relationship between the extent of IBL implementation and its perceived effectiveness. An independent samples t -test was applied to identify significant differences between the assessments of science teachers and Grade 10 students regarding implementation and perceived effectiveness. Statistical computations were performed using a recognized statistical software package, such as SPSS or its equivalent, with a significance level of $p < .05$ established as the criterion for statistical significance. The results served as the basis for identifying instructional needs and developing a professional development program for science teachers.

2.8 Ethical Considerations

The study observed ethical principles to protect the rights, privacy, and welfare of all participants. Formal authorization was obtained from the Schools Division Office of Panabo City and the principals of the participating schools before data collection. Participation was voluntary, and respondents were informed of their right to refuse or withdraw without penalty. Written informed consent was secured from teachers, while parental or guardian consent and student assent were obtained for Grade 10 participants. Confidentiality and anonymity were maintained by excluding personal identifiers from the questionnaires, coding responses, and presenting findings in aggregate form. Research data were securely stored, accessed only by the researcher, and destroyed after the completion and acceptance of the thesis. The study was guided by the principles of respect for persons, beneficence, and justice outlined in the 2022 National Ethical Guidelines for Research Involving Human Participants issued by the Philippine Health Research Ethics Board (PHREB, 2022), and complied with the Data Privacy Act of 2012 (Republic Act No. 10173).

3. Results and Discussion

3.1 Demographic Profile of Science Teachers

3.1.1 Age, Sex, Educational Attainment, and Teaching Experience

The findings revealed that most teacher-respondents were Millennials aged 28–43 years (70.97%), followed by Generation X aged 44–59 years (16.13%) and Generation Z aged 18–27 years (12.90%). Female teachers comprised 74.19%, while males accounted for 25.81%. Regarding educational attainment, 54.84% held bachelor's degrees, 35.48% had master's degrees, and 9.68% possessed doctoral degrees. In terms of teaching experience, the largest group had served for 6–10 years (38.71%), followed by those with 1–5 years (19.35%) and 11–15 years (12.90%). The remaining respondents belonged to other experience categories. These findings indicate that the respondents were predominantly teachers in the early to middle stages of their careers, with varied academic qualifications and professional experience. The Organization for Economic Co-operation and Development (OECD, 2023) provides comparative information on teachers' educational qualifications and professional characteristics, offering a broader context for understanding differences in teacher profiles across education systems. Similarly, UNESCO and the International Task Force on Teachers for Education 2030 (2024) emphasized the importance of strengthening initial teacher education and continuous professional development to support a qualified, well-prepared, and professionally supported teaching workforce.

3.2 Extent of Implementation of Inquiry-Based Learning Strategies

3.2.1 Structured Inquiry

Science teachers assessed structured inquiry as Highly Implemented ($M = 4.82$, $SD = 0.21$), while students rated it as Implemented ($M = 4.37$, $SD = 0.55$). Teachers assigned the highest mean of 4.90 to providing clear instructional guidance and continuous support during inquiry activities. Students similarly gave the highest rating ($M = 4.52$) to receiving clear directions. The results indicate that structured inquiry was regularly practiced, although teachers reported higher implementation than students. These findings emphasize the importance of instructional guidance in helping students participate in scientific investigations. Petersen (2022) explained that effective scaffolding promotes meaningful inquiry while gradually developing learner independence. Likewise, Urdanivia Alarcon et al. (2023) highlighted the value of structured support in strengthening scientific reasoning, problem-solving skills, and conceptual understanding.

3.2.2 Guided Inquiry

Teachers rated guided inquiry as Highly Implemented ($M = 4.71$, $SD = 0.29$), whereas students assessed it as Implemented ($M = 4.19$, $SD = 0.63$). Teachers gave the highest rating ($M = 4.80$) to providing opportunities for independent thinking with instructional support. Students rated interactive classroom discussions highest ($M = 4.34$), while opportunities for independent decision-making received a lower rating ($M = 3.90$). These findings show that guided inquiry was practiced consistently, although students perceived fewer opportunities for independent investigation. The results suggest that guided inquiry balances teacher facilitation and student participation, but learner autonomy requires further strengthening. de Jong (2023) emphasized that appropriate instructional guidance allows students to investigate scientific problems actively while developing independence and meaningful understanding.

3.2.3 Open Inquiry

Teachers assessed open inquiry as Implemented ($M = 4.45$, $SD = 0.51$), while students also rated it as Implemented ($M = 3.96$, $SD = 0.72$). These results indicate that open inquiry was practiced in science classrooms but received lower assessments than structured and guided inquiry. Both groups recognized opportunities for student-led investigations and discussions, although the students' lower mean indicated less frequent experiences of independent inquiry activities. The findings suggest that open inquiry requires greater learner independence in investigating problems, interpreting evidence, and drawing conclusions. Compared with structured and guided inquiry, its lower implementation ratings indicate an area for instructional improvement, particularly in helping students assume greater responsibility for scientific investigations.

3.3 Perceived Effectiveness of Inquiry-Based Learning Strategies

3.3.1 Enhancing Student Engagement

Teachers rated IBL as Highly Effective in enhancing student engagement ($M = 4.68$, $SD = 0.31$), while students assessed it as Effective ($M = 4.16$, $SD = 0.57$). Teachers gave the highest rating ($M = 4.74$) to activities encouraging interaction and collaboration. Students assigned the highest rating ($M = 4.25$) to activities that maintained their participation and attention during science lessons. Both groups recognized the positive contribution of IBL to classroom engagement. These findings indicate that inquiry-based activities encourage active participation, interaction, and collaborative learning. Gillies (2023) emphasized that collaborative scientific investigations strengthen student engagement through questioning, evidence evaluation, and communication. Similarly, Urdanivia Alarcon et al. (2023) explained that inquiry-based instruction promotes meaningful classroom interaction and active learner involvement.

3.3.2 Promoting Conceptual Understanding

Teachers perceived IBL as Highly Effective in promoting conceptual understanding ($M = 4.80$, $SD = 0.30$), whereas students rated it as Effective ($M = 4.13$, $SD = 0.63$). Teachers gave the highest mean ($M = 4.87$) to connecting scientific concepts with real-world situations, while students similarly rated this aspect highest ($M = 4.29$). The lowest student rating ($M = 3.96$) indicated that some learners experienced greater difficulty explaining scientific phenomena. These results suggest that IBL supports meaningful understanding by connecting scientific concepts with practical experiences. Urdanivia Alarcon et al. (2023) emphasized that investigation, evidence gathering, and reflection help learners construct scientific knowledge. Similarly, Strat et al. (2024), in their systematic review of inquiry-based science education in teacher education, reported favorable outcomes in science understanding, teaching competence, and prospective teachers' attitudes and self-efficacy. These findings highlight the potential value of inquiry-based approaches when supported by appropriate teacher preparation.

3.3.3 Developing Scientific Inquiry Skills

Teachers assessed IBL as Highly Effective in developing scientific inquiry skills ($M = 4.68$, $SD = 0.38$), while students rated it as Effective ($M = 4.00$, $SD = 0.66$). Teachers gave the highest rating ($M = 4.84$) to developing observational and critical-thinking abilities, while students similarly rated this aspect highest ($M = 4.18$). The lowest student rating ($M = 3.87$) indicated comparatively greater difficulty in independently planning investigations and applying scientific procedures. These findings demonstrate that IBL provides opportunities to strengthen observation, critical thinking, investigation, and evidence-based reasoning. Couso Lagaron et al. (2024) emphasized that authentic scientific inquiry develops learners' ability to question, analyze evidence, interpret data, and construct explanations. Likewise, Urdanivia Alarcon et al. (2023) noted that active scientific exploration supports investigative and critical-thinking skills.

3.3.4 Encouraging Collaborative Learning

Teachers rated IBL as Highly Effective in encouraging collaborative learning ($M = 4.69$, $SD = 0.36$), whereas students assessed it as Effective ($M = 4.14$, $SD = 0.60$). Teachers gave the highest rating ($M = 4.74$) to productive group work and shared responsibility. Students rated teamwork and collective problem-solving highest ($M = 4.27$), while communication during group discussions received a lower rating ($M = 3.98$). These findings indicate that collaborative inquiry was positively perceived, although students reported varying levels of participation and communication. The results highlight the importance of shared investigations and group interaction in developing teamwork and interpersonal competencies. Gillies (2023) emphasized that collaborative inquiry strengthens communication, responsibility, and knowledge construction. Similarly, Hernández-de-Menéndez et al. (2022) explained that collaborative learning environments promote active participation, problem-solving, and interpersonal skills essential for meaningful learning.

3.3.5 Improving Problem-Solving Abilities

Teachers perceived IBL as Highly Effective in improving problem-solving abilities ($M = 4.72$, $SD = 0.35$), while students rated it as Effective ($M = 4.03$, $SD = 0.69$). Teachers assigned the highest rating ($M = 4.77$) to systematic problem-solving and developing appropriate solutions. Students gave the highest rating ($M = 4.16$) to creative and critical thinking, while evaluating outcomes and refining solutions received the lowest rating ($M = 3.86$). These

findings indicate that inquiry-based instruction supports analytical thinking, evidence evaluation, and the development of possible solutions to scientific problems. However, students may require further practice in evaluating and improving their solutions. Zhang et al. (2023) emphasized that inquiry-based learning strengthens problem-solving abilities through authentic tasks, critical analysis, evidence-based reasoning, and systematic investigation.

3.4 Relationship Between the Extent of IBL Implementation and Its Perceived Effectiveness

3.4.1 Relationship Based on Teachers' Assessments

The correlation analysis revealed weak positive relationships between the extent of IBL implementation and the five dimensions of perceived effectiveness, with correlation coefficients ranging from 0.298 to 0.331 and p-values from 0.069 to 0.103. Since these p-values exceeded the 0.05 significance level, the relationships were not statistically significant. However, the overall assessment showed a moderate positive and significant relationship ($r = 0.403$, $p = 0.025$), resulting in the rejection of the null hypothesis for the overall relationship. These findings suggest that the collective implementation of IBL strategies is more strongly associated with teachers' perceived effectiveness than individual learning dimensions. Cairns and Areepattamannil (2022) found that explicit teacher-directed instructional practices, particularly clear explanations of scientific ideas, were positively associated with students' science achievement. Their findings highlight the importance of instructional guidance in science education. In the present study, the significant overall relationship suggests that the implementation of inquiry-based learning strategies is associated with teachers' perceived instructional effectiveness.

3.4.2 Relationship Based on Students' Assessments

Students' assessments revealed statistically significant positive relationships between IBL implementation and all five dimensions of perceived effectiveness. Correlation coefficients ranged from 0.50 to 0.61, with all reported p-values below .001. Collaborative learning demonstrated the strongest relationship ($r = 0.61$), while conceptual understanding had the lowest ($r = 0.50$). The overall relationship was also positive and statistically significant ($r = .63$, $p < .001$), leading to the rejection of the null hypothesis. These findings indicate that students who experienced greater implementation of IBL strategies also perceived greater instructional effectiveness. The National Academies of Sciences, Engineering, and Medicine (2022) emphasized that sustained inquiry experiences promote scientific reasoning, conceptual understanding, collaboration, and problem-solving. Likewise, de Jong (2023) explained that consistent inquiry-based instruction, supported by appropriate guidance, strengthens student engagement and learning.

3.5 Significant Differences Between Teachers' and Students' Assessments

3.5.1 Differences in the Extent of IBL Implementation

The results revealed a statistically significant difference between teachers' and students' assessments of IBL implementation. Teachers reported a higher overall mean ($M = 4.66$) than students ($M = 4.17$). The computed test value was 4.92, with a p-value below .001, indicating a significant difference at the 0.05 level. Consequently, the null hypothesis was rejected. The difference suggests that teachers perceived inquiry-based strategies as more extensively implemented than students experienced them. Hattie (2023) emphasized the importance of evaluating teaching practices through evidence of their effects on student learning and aligning instructional strategies with learning needs. In the present study, the differences between teachers' and students' assessments highlight the importance of considering student feedback when evaluating the implementation of inquiry-based learning strategies.

3.5.2 Differences in the Perceived Effectiveness of IBL Strategies

A statistically significant difference was also found between teachers' and students' assessments of IBL effectiveness. Teachers reported a higher overall mean ($M = 4.71$) than students ($M = 4.09$). The computed test value was 6.02, with a p-value below .001, resulting in the rejection of the null hypothesis. Although both groups provided positive assessments, teachers consistently perceived IBL as more effective. These findings indicate differences in how teachers and students evaluate the learning benefits of inquiry-based instruction. The difference between teachers' and students' assessments in the present study indicates that instructional effectiveness may be perceived differently by the two respondent groups. Considering both perspectives is therefore important in identifying instructional gaps and improving the quality of classroom learning.

3.6 Proposed Professional Development Program for Science Teachers

3.6.1 Basis and Objectives of the Proposed Program

The findings revealed that teachers generally rated IBL strategies as Highly Implemented and Highly Effective, whereas students provided lower but favorable assessments. Significant differences between the two groups were observed in both implementation and perceived effectiveness. The relationship analysis also showed a significant overall association between implementation and effectiveness. These findings provided the basis for developing INQUIRE+: An Evidence-Informed Professional Development Program for Strengthening Science Teachers' Implementation of Inquiry-Based Learning. The proposed program addresses the identified differences in classroom perceptions and aims to strengthen teachers' pedagogical knowledge, instructional planning,

facilitation, assessment, and reflective practices. It emphasizes the importance of aligning teachers' instructional intentions with students' actual learning experiences through continuous professional learning and evidence-based instructional improvement.

3.6.2 Program Framework and Implementation

The proposed INQUIRE+ program adopts a school-based professional learning approach organized into seven interrelated phases. It begins with needs assessment and instructional analysis, followed by professional learning activities intended to strengthen teachers' knowledge and implementation of structured, guided, and open inquiry. The program incorporates collaborative lesson planning, Learning Action Cell (LAC) sessions, lesson study, peer coaching, mentoring, classroom application, reflection, and continuous improvement. The program emphasizes sustained professional learning rather than isolated training activities. Collaborative planning and instructional coaching are intended to help teachers improve inquiry-based lessons, address classroom challenges, and develop strategies responsive to students' learning needs. These activities support the proposed program's goal of strengthening instructional competence and promoting more consistent implementation of IBL strategies.

3.6.3 Monitoring, Evaluation, and Sustainability

The proposed program includes a monitoring and evaluation plan using classroom observations, lesson plan reviews, teacher reflection journals, student feedback, coaching reports, and LAC documentation. These sources of evidence are intended to assess instructional implementation, identify areas requiring improvement, and guide subsequent professional learning activities. The sustainability plan also provides for continued lesson study, mentoring, peer coaching, and collaborative inquiry through school-based professional learning structures. The monitoring and sustainability components are designed to support continuous instructional improvement and institutionalize inquiry-based professional learning. Regular evaluation and feedback are expected to help teachers refine their instructional practices and respond to differences between teacher and student perceptions. The INQUIRE+ program remains a proposed intervention based on the study's findings; its actual effectiveness would require evaluation following implementation.

4. Conclusion & Recommendations

The study concluded that Inquiry-Based Learning (IBL) strategies are generally well integrated into science instruction and perceived as effective in enhancing student engagement, conceptual understanding, scientific inquiry skills, collaborative learning, and problem-solving abilities. The teacher-respondents were predominantly early- to mid-career female educators with adequate qualifications and teaching experience. Teachers consistently reported higher levels of IBL implementation and effectiveness than students, indicating differences in their classroom perceptions. A significant positive relationship was established between IBL implementation and perceived effectiveness, with students demonstrating stronger and more consistent associations across learning outcomes. Significant differences between teachers' and students' assessments further emphasized the need to align instructional practices with students' learning experiences. These findings provided the basis for the proposed INQUIRE+ Professional Development Program, an evidence-informed framework designed to strengthen teachers' competencies and improve inquiry-based Science instruction.

School administrators are encouraged to strengthen institutional support for IBL through continuous professional development, adequate instructional resources, and regular instructional supervision. Science teachers should enhance student-centered instruction, reflective teaching, authentic assessment, and differentiated learning approaches while incorporating student feedback to address differences in classroom perceptions. Science department heads and instructional leaders may establish school-based interventions, mentoring, and instructional coaching to strengthen teachers' pedagogical competencies. Schools are encouraged to consider implementing the proposed INQUIRE+ Professional Development Program as a sustainable framework for improving inquiry-based instructional practices. Future researchers may conduct similar studies with larger and more diverse samples, examine additional variables such as Science achievement, learner motivation, instructional leadership, and teacher self-efficacy, and employ qualitative or mixed-methods approaches to further understand IBL implementation and perceived effectiveness across educational contexts.

5. Compliance with ethical standards

The study adhered to established ethical principles, including informed consent, voluntary participation, confidentiality, and respect for participants' rights. Necessary permissions were obtained from the Schools Division Office and participating schools. Written consent was secured from teacher-respondents, while parental consent and student assent were obtained for student-respondents. Participants were informed of their right to withdraw without penalty. All collected data were treated confidentially, used solely for academic purposes, and handled in accordance with the Data Privacy Act of 2012 (Republic Act No. 10173). The study upheld research integrity, transparency, and the protection of participants throughout the research process.

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