IJSES
International Journal of Scientific Engineering and Science
Volume 10, Issue 5, pp. 18-26, 2026. ISSN (Online): 2456-7361

Using Inquiry Base Instruction in Enhancing Students' Performance in Science

Gino P. Sanoy, Grace A. Flores
College of Education, Misamis University, Ozamiz City

***Abstract*— *This study evaluated the effectiveness of Inquiry-Based Instruction (IBI) in enhancing college students' science performance and scientific inquiry skills using a one-group pretest-posttest design, revealing statistically significant improvements in both areas after the intervention. The findings highlight the potential of IBI to foster deeper conceptual understanding and engagement, supporting its broader application in science education to promote meaningful, skill-based learning.*

***Keywords*— *Active Learning Strategies, Higher-Order Thinking Skills, Science Achievement.*

I. INTRODUCTION

An overview of the state of science education in the Philippines is provided in this paper. This also includes the government's mandates and efforts to maintain its science education program in light of the 21st century's changes. The Philippines' science curriculum was put in place to create scientifically literate people who can make responsible decisions and use scientific knowledge to solve community issues. However, among participating nations where science was one of the disciplines assessed, the Philippines came in last in the most recent results of the Programme for International Student Assessment (PISA) 2018 (De La Cruz, 2022).

Instead of having students learn science directly from teachers, inquiry-based science instruction helps them learn science indirectly by having them carry out their own scientific investigations (Jerrim et al., 2022). It has been said that one of the most effective ways to teach science is through inquiry-based learning (García-Carmona, 2020). Students have been encouraged to learn science through the use of inquiry method. For student-centered inquiry instruction to be successfully implemented in the classroom, teachers' formative assessment practices must be developed (Correia & Harrison, 2020).

Research skills and scientific knowledge construction are made possible by the application of the inquiry-based educational strategy. This method, when combined with good teaching techniques, makes science more approachable by enabling the modeling of theories and laws in the actual world. Teaching science has a propensity to employ constructivism teaching approaches, have high standards based on evidence, and use scientific reasoning to attain learning. It is stressed that teachers must receive ongoing training in order to comprehend scientific knowledge and become proficient in open inquiry implementation techniques (Urdanivia et al., 2023).

Creating effective learning materials based on the inquiry learning model and incorporating scientific literacy has become a popular approach in education to promote active learning. Developing critical thinking skills is essential for helping students gain the competencies needed for problem-solving and discovery in science education (Sutiani, 2021). Inquiry-based science education has been shown to have positive effects on students' attitudes or self-efficacy, teaching proficiency, and scientific comprehension (Strat et al., 2024). Students' scientific process abilities, including problem definition, hypothesis formulation, observation, and interpretation, were enhanced via inquiry-based learning activities. Furthermore, students' abilities to use scientific terminology, create understandable scientific illustrations, and provide scientific justifications increased (Mutlu, 2020).

Addressed inadequate science proficiency brought on by poor educational methods. After employing inquiry-based materials, students' integrated science process abilities significantly improved. Students' comprehension and performance in science are successfully improved by inquiry-based tools (Ederon & Aliazas, 2024). By empowering students to take control of their education and encouraging active inquiry, critical thinking, and problem-solving, inquiry-based science teaching transforms conventional classroom settings. This method fosters a lifetime love of research and advances scientific understanding (Guerrero & Bautista, 2023). It is essential to exhibit higher order thinking abilities in order to succeed in a complicated, ambiguous, unpredictable, and volatile environment. Inquiry-based learning is becoming more widely acknowledged as a powerful strategy for fostering students' higher-order thinking abilities in science classes. To improve their teaching methods and help students develop their higher-order thinking abilities, science instructors are also urged to adopt inquiry-based approaches (Antonio & Prudente, 2024).

Students' attitudes toward science were more positively predicted by inquiry-based teaching methods than by teacher-directed methods. Contrary to the widely held notion that inquiry-based science instructional techniques enhance student science achievement, there is an adverse relationship between inquiry-based science instructional practices and science achievement (Liou, 2021). The way that students view science courses, particularly chemistry, has been ascribed to the application of inquiry-based education. The students' academic success is significantly predicted by attitudes (Nzomo et al., 2023). The possibilities of inquiry-based teaching as an effective teaching strategy to encourage science learning. This method, which highlights compared to conventional approaches, student-centered exploration and discovery seems to promote a deeper comprehension of scientific concepts.

Incorporating inquiry-based methods into scientific curricula have the power to dramatically raise student engagement and achievement (Edillor, 2024).

An appeal for students to comprehend more deeply so that they are able to comprehend and apply what they've learned to real-world scenarios has had an impact on science education in the Philippines. Teachers, educators, and legislators have responded by adopting contextualization as a constructivist method for establishing a connection between ideas and actual experiences (Picardal & Sanchez, 2022). Students with varying levels of academic success in science might benefit from a guided inquiry learning environment by being encouraged to participate fully in science inquiry (Wen et al., 2020). This study aims to determine the effectiveness of using inquiry-based instruction in improving students' performance and scientific inquiry skills in science. It focuses on measuring students' learning before and after the implementation of this teaching approach. The researchers believe that applying inquiry-based learning allows students to explore, investigate, and discover scientific concepts on their own, which may result in better understanding and retention of knowledge. This approach is also expected to strengthen students' critical thinking, problem-solving abilities, and engagement in science-related activities.

Inquiry-based instruction has been widely studied for its impact on science learning, student engagement, and the development of critical thinking skills. However, most previous studies have focused on general educational settings or were conducted outside the Philippine context. There is a noticeable lack of localized research that explores how inquiry-based instruction directly affects students' performance and scientific inquiry skills within the Philippine basic education curriculum. Additionally, limited attention has been given to how this approach can address the declining science proficiency among Filipino students as shown in international assessments like PISA. Hence, this study fills a crucial gap by providing empirical evidence on the use of inquiry-based instruction in improving the science performance of Filipino learners, particularly in secondary schools. This unexplored area has drawn growing interest due to recent shifts in educational priorities, making it relevant for further investigation (Miles, 2017).

Theoretical Framework

This study is anchored on three foundational learning theories: the Constructivist Learning Theory by Jean Piaget (1952) and Lev Vygotsky (1978), the Discovery Learning Theory by Jerome Bruner (1961), and the Experiential Learning Theory by David Kolb (1984).

Piaget and Vygotsky emphasized that learners actively construct knowledge through interaction with their environment and social context. This constructivist approach underlies the shift in Philippine science education from rote memorization to deeper understanding and contextualized learning, especially in response to the nation's poor performance in international assessments like PISA 2018 (De La Cruz, 2022). In this context, inquiry-based instruction emerges as a student-centered approach that allows learners to explore and make sense of scientific concepts independently (Jerrim, 2022).

The implementation of inquiry-based teaching also aligns with Bruner's Discovery Learning Theory, which asserts that students learn more effectively when they discover knowledge for themselves through guided activities and problem-solving. This method fosters scientific reasoning and critical thinking, particularly when supported by well-designed instructional strategies and teacher guidance (García-Carmona, 2020; Correia, 2020).

Kolb's Experiential Learning Theory, which outlines a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation, further supports the inquiry-based approach. In inquiry-based classrooms, students engage in hands-on investigations, reflect on their observations, derive scientific concepts, and apply them to real-world scenarios—consistent with Kolb's model of deep learning (Urdanivia, 2023). Studies have shown that inquiry-based instruction improves students' scientific process skills, such as hypothesis formulation and data interpretation (Mutlu, 2020), enhances scientific comprehension and academic performance (Ederon & Aliazas, 2024), and fosters higher-order thinking skills necessary in today's complex world (Antonio & Prudente, 2024). It positively shapes student attitudes toward science (Nzomo, 2023) and increases engagement, especially when instruction is contextualized and aligned with students' lived experiences (Picardal & Sanchez, 2022).

Despite these advantages, there remains a gap in localized research that examines the direct effects of inquiry-based instruction on Filipino students' performance and inquiry skills in science. Thus, this study aims to determine the effectiveness of using inquiry-based instruction in improving learners' understanding and competence in scientific inquiry. Rooted in constructivist, discovery, and experiential learning theories, the study hypothesizes that such an approach fosters active exploration, critical thinking, and meaningful knowledge retention—key goals of science education in the 21st century.

Conceptual Framework

The present study is grounded on the growing need to reform science education in the Philippines, as revealed by the country's poor performance in international assessments like PISA 2018 (De La Cruz, 2022). This underperformance is largely attributed to traditional, teacher-centered methods that limit student engagement and critical thinking. Drawing from the constructivist learning theory, inquiry-based instruction (IBI) positions learners as active participants who construct knowledge through exploration and investigation (García-Carmona, 2020; Urdanivia et al., 2023). Instead of passively receiving information, students are encouraged to ask questions, formulate hypotheses, carry out experiments, and draw conclusions (Jerrim et al., 2022; Mutlu, 2020). This active process develops their scientific inquiry skills—such as observation, interpretation, and evidence-based reasoning—and nurtures critical and higher-order thinking abilities (Sutiani, 2021; Antonio & Prudente, 2024).

Studies suggest that when properly implemented, IBI improves science performance, fosters scientific attitudes, and increases student engagement (Ederon & Aliazas, 2024; Strat et al., 2024; Guerrero & Bautista, 2023). However, localized evidence, particularly in the Philippine secondary education context, remains limited (Miles, 2017). The contextualization of science content and adoption of inquiry-driven activities could address existing gaps and promote deeper learning, especially when aligned with national curriculum reforms (Picardal & Sanchez, 2022). This study investigates the effectiveness of inquiry-based instruction in enhancing science performance and scientific inquiry skills among college students in the Philippines.

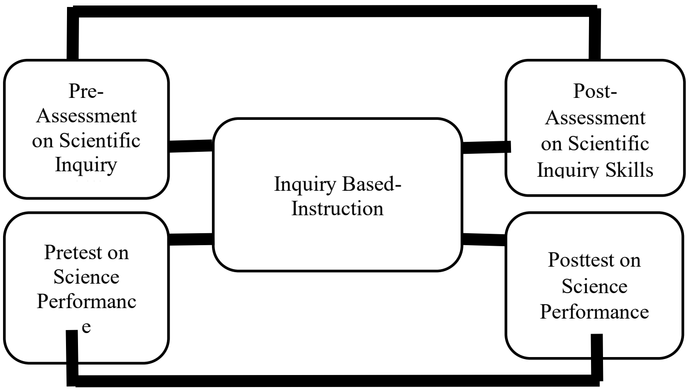

Fig. 1. Schematic Diagram of the Study

Statement of the Problem

This study investigated the effectiveness of inquiry-based instruction (IBI) in enhancing students' science performance during the second semester of the 2024–2025 academic year. This study sought to answer the following questions:
1. What is the learners' performance before the implementation of inquiry-based instruction?
2. What is the learners' level of scientific inquiry skills before the implementation of inquiry-based instruction?
3. What is the learners' performance after the implementation of inquiry-based instruction?
4. What is the learners' level of scientific inquiry skills after the implementation of inquiry-based instruction?
5. Is there a significant difference between the learners' performance in science before and after the implementation of inquiry-based instruction?
6. Is there a significant difference between the learners' level of scientific inquiry skills before and after the implementation of Inquiry based instruction?

Null Hypotheses

Ho: There is no significant difference between using inquiry-based instructions enhancing students' performance in science
Ha: There is a significant difference between using inquiry-based instructions enhancing students' performance in science

II. RESEARCH METHODOLOGY

Research Design

This quantitative approach used a one-group pretest-posttest design to assess the effectiveness of Inquiry-Based Instruction (IBI) on the academic performance of students taking a science-related course. This pre-experimental approach introduced an intervention or manipulation of the independent variable, analyzed a group of respondents by means of a pretest, and subsequently evaluated the outcomes by means of a posttest (Marcos et al., 2024).

In this study, 25 students taking a science-related course were tested using a one-group pretest-posttest design. This method enabled the assessment of learning improvements within the same group. This design assessed whether Inquiry-Based Instruction effectively improved students' scientific reasoning, problem-solving, and scientific inquiry skills by comparing pretest and posttest results.

Research Setting

This study was conducted at one of the higher education institutions in Ozamiz City, Misamis Occidental, known for its comprehensive educational programs from early childhood to senior high school. The setting aligned with the science curriculum and offered a diverse student sample. With specialized tracks like STEM and HUMSS, the institution prepared students for higher education and the workforce. Its commitment to quality education and openness to innovative teaching methods, such as inquiry-based instruction, made it an ideal setting for assessing the impact on student performance through pre- and post-testing. The College of Education program was selected for data collection, as future educators were developing critical thinking and higher-order thinking skills, making them ideal for assessing the effectiveness of these methods.

Respondents of the Study

The respondents of this study were 25 students enrolled in a science-related course at one of the higher education institutions in Ozamiz City, Misamis Occidental. They were chosen using purposive non-random sampling. They were selected based on specific criteria to ensure the validity of the results. The selection criteria included the following: students must have been currently enrolled in a subject where Inquiry-Based Instruction (IBI) could be implemented; they must have been available to take both the pretest and post-test; and they must have had regular attendance in class to ensure consistent exposure to the intervention. Respondents must agreed and sign the informed consent form and be available for surveys, interviews, or other data collection methods during the research period.

Research Instrument

This study used the following questionnaire as the data-gathering instrument:
A. Inquiry-Based Learning Assessment (Appendix A)

The researcher-designed Inquiry-Based Learning (IBL) Assessment, embedded within the lesson plan, measured students' academic performance and engagement in an inquiry-based learning environment over a span of four sessions. Each 60-minute session consisted of a 10-minute pretest, a 40-minute

Volume 10, Issue 5, pp. 18-26, 2026. ISSN (Online): 2456-7361

student-led investigation and discussion, and ended with a 10-minute posttest to track learning progress.

The IBL Assessment focused on key scientific and mathematical concepts aligned with the curriculum, covering topics such as scientific inquiry, hypothesis testing, experimental design, data analysis, and problem-solving strategies. Each test session consisted of application-based and conceptual questions, scored on a 30-point scale.

The content validity, construct validity, and reliability of the IBL assessment were established through expert validation, pilot testing, and statistical analysis, including Cronbach's alpha. Subject matter experts and experienced educators reviewed the test items to ensure alignment with the learning competencies and inquiry-based pedagogy. The instrument also underwent student and teacher feedback to confirm clarity and relevance.

To determine students' academic performance, the study uses the following scale

Scale	Interpretation
47-50	Outstanding
44-46	Very Satisfactory
42-43	Satisfactory
40-41	Fairly
38-39	Poor
37 and below	Very Poor

B. Lesson plan (Appendix B). In this study, Inquiry-Based Instruction (IBI) was integrated into the science curriculum with an emphasis on scientific inquiry, experimental design, and data analysis. Each of the four sessions began with a pretest to assess students' prior knowledge, followed by a teacher-guided inquiry activity in which students explored scientific concepts through hands-on experiments and problem-solving tasks. After each activity, a posttest was administered to evaluate learning gains and the impact of IBI on students' scientific reasoning and critical thinking skills. The study compared pretest and posttest scores to determine the effectiveness of IBI in enhancing students' abilities to analyze data, formulate hypotheses, and apply scientific concepts to real-world scenarios over a four-week period.

C. Learners' Level of Scientific Inquiry Skills (Appendix C), a researcher-made instrument, was designed to assess students' level of scientific inquiry skills using a 4-point Likert scale, with responses scored as (4) Always, (3) Often, (2) Sometimes, and (1) Never. The instrument comprised 25 items, grouped into five constructs: Defining Problems (5 items), Carrying Out Investigations (5 items), Analyzing Data (5 items), Constructing Explanations (5 items), and Communicating Findings (5 items). This questionnaire was relevant to the study as it specifically targeted the learners' scientific inquiry skills in science. It was administered as both a pre-assessment (before the intervention) and a post-assessment (after the completion of the sessions) to measure changes in inquiry skills as a result of the Inquiry-Based Assessment (IBA) intervention. To determine the learners' level of critical thinking skills toward the implementation of problem-based assessment, the study used the following continuum:

Responses	Continuum	Interpretation
4-Always	3.25-4.0	Very Good
3-Often	2.5-3.24	Good
2-Sometimes	1.75-2.49	Poor
1-Never	1.0-1.74	Very Poor

Data Gathering Procedure

Before the data collection process, the researcher obtained formal approval from the Dean of the College of Education. After institutional approvals, informed consent forms were distributed. The study was conducted with the College of Nursing students to examine the impact of Inquiry-Based Learning (IBL) on their academic performance. The data collection spanned one month and consisted of four sessions. Each session followed a structured quantitative assessment process to measure students' performance improvements. At the beginning of the study, a researcher-made pretest was administered to assess students' baseline knowledge of the selected topics in science. The pretest consisted of 50 multiple-choice questions, aligned with the curriculum and validated by subject matter experts.

During the intervention, each session began with a 10-minute pretest, followed by a 40-minute inquiry-based learning activity, and concluded with a 10-minute quiz. The posttest, like the pretest, contained concept-based multiple-choice questions that directly measured knowledge acquisition from the session. While the format remained consistent, the test content varied according to the lesson topic. To further assess the effectiveness of Inquiry-Based Learning, a 25-item Likert-scale survey questionnaire was administered before and after the study. The survey measured students' critical thinking skills, problem-solving abilities, and engagement. Responses were recorded on a 4-point scale, with options ranging from (4) Always to (1) Never.

To ensure the reliability and validity of the data collection instruments, the pretest and posttest underwent pilot testing, and internal consistency was measured using Cronbach's Alpha. After the final session, descriptive and inferential statistical analyses were conducted, including paired t-tests to compare pretest and posttest scores and determine the effectiveness of Inquiry-Based Learning. The Likert-scale responses were analyzed using mean scores and standard deviation to identify significant changes in student engagement and problem-solving skills.

Ethical Considerations

Prior to conducting the study, the researcher ensured that all ethical concerns were addressed to protect the participants' rights and well-being, ensuring adherence to ethical guidelines for research involving human participants. The study adhered to Kang's (2021) principles as well as the ethical standards established by Republic Act No. 10173 (Data Privacy Act of 2012) to protect participant privacy and prevent any potential risks associated with the study. To maintain ethical integrity, strict informed consent and assent procedures were implemented prior to data collection. All participants were fully informed of the study's purpose, procedures, potential risks, and benefits.

Participation in the study was entirely voluntary, and respondents were allowed to withdraw at any time without penalty. The study also adhered to the principles of confidentiality and anonymity by ensuring that all collected data were free of identifiable information. Data were securely stored, with access restricted to authorized researchers only. All findings were reported in aggregate form, so that individual responses could not be linked to specific participants. Furthermore, to maintain research integrity, the researcher strictly followed the principles of nonmaleficence, beneficence, and justice. The ethical measures used in this study were designed to protect participants' rights, privacy, and dignity while also ensuring the credibility and integrity of the research.

Data Analysis

This study used Jamovi, a statistical software, to analyze the quantitative data collected. The following statistical tools were used to effectively interpret the results:

Frequency and percentage were used to compare the performance of students before and after the Inquiry-Based Instruction (IBI) intervention. The study identified changes in students' performance and evaluated the intervention's impact by calculating the frequency and percentage distribution of scores.

Mean and standard deviation were used to assess the central tendency and variability of learners' scores on both the pretest and posttest. The mean revealed overall performance improvements in science-related subjects and scientific inquiry skills, whereas the standard deviation demonstrated the consistency of student responses across assessments.

A paired t-test was used to compare pretest and posttest scores and determine the statistical significance of changes in students' scientific reasoning, critical thinking, and conceptual understanding. This test determined whether Inquiry-Based Instruction had a significant impact on student learning outcomes.

III. Results And Discussion

Learners' Performance Before the Implementation of Inquiry-Based Instruction.

Table 1 presents the performance levels of the participants based on the predefined scale. The overall performance score was categorized as very poor (M = 22.40), indicating that participants, on average, performed well below the satisfactory threshold. Notably, the entire sample of respondents (n = 25, 100%) fell under the very poor performance category, highlighting a uniform trend of low performance across all individuals assessed.

TABLE 1. Learners' Performance Before the Implementation of Inquiry-Based Instruction

Performance	Frequency	Percentage
Very Poor	25	100
Overall Performance	22.40	

Note: Scale: 47-50 (Outstanding); 44-46 (Very Satisfactory); 42-43 (Satisfactory); 40-41 (Fair); 38-39 (Poor); 37 and below (Very Poor)

The data reveal a concerning uniformity in the performance levels of the participants, with all scoring within the *very poor* category. The mean score (M = 22.40) is significantly lower than the minimum threshold for the *poor* category (38), suggesting not just marginal underperformance but a substantial gap from the expected competencies. Such results may reflect systemic issues in instructional delivery, student engagement, or understanding of the subject matter. The lack of variance in the scores (100% in one category) could also imply that external factors influencing performance—such as teaching strategies, access to resources, or assessment alignment—are uniformly affecting all students in a negative manner.

The findings suggest a critical need for immediate intervention by school administrators, curriculum developers, and teaching personnel. Given the uniformly poor performance, targeted activities should be implemented to bridge learning gaps. These could include remedial classes, individualized learning plans, and more engaging, inquiry-based teaching strategies. Regular formative assessments should also be administered to monitor progress and inform instruction. Professional development for teachers focused on differentiated instruction and effective assessment design may also help enhance student performance. Overall, a collaborative and responsive approach is necessary to improve learning outcomes and prevent long-term academic failure among students.

Learners' Level of Scientific Inquiry Skills Before the Implementation of Inquiry-Based Instruction

Table 2 presents the learners' level of scientific inquiry skills before the implementation of inquiry-based instruction. The overall mean score (M = 2.3536, SD = 0.2635) indicates a low level of scientific inquiry skills among the learners. Among the five indicators, the highest mean score was recorded in Planning and Carrying Out Investigations (M = 2.7440, SD = 0.2973), though still within the low category. This was followed by Constructing Explanations (M = 2.4400, SD = 0.3055), Asking Questions and Defining Problems (M = 2.2800, SD = 0.2236), Communicating Findings (M = 2.1840, SD = 0.2996), and the lowest in Collecting and Analyzing Data (M = 2.1200, SD = 0.1915).

TABLE 2. Learners' Level of Scientific Inquiry Skills Before the Implementation of Inquiry-Based Instruction

Variables	Mean	SD	Remarks
Asking Questions and Defining Problems	2.28	0.22	Low
Planning and Carrying Out Investigations	2.74	0.39	Low
Collecting and Analyzing Data	2.12	0.19	Low
Constructing Explanations	2.44	0.31	Low
Communicating Findings	2.18	0.30	Low
Overall	2.35	0.26	Low

Note: Scale: 3.25-4.00 (Very High); 2.5-3.24 (High); 1.75-2.49 (Low); 1.0-1.74 (Very Low)

The data reveal that students generally struggled with various components of scientific inquiry prior to the application of inquiry-based instruction. While Planning and Carrying Out Investigations had the relatively highest mean, the skill still did not reach the high category, suggesting limited ability in designing and executing scientific procedures independently. Constructing Explanations fared similarly, which may imply that while learners could begin formulating interpretations, they likely lacked depth and accuracy in doing so. Particularly low scores in Collecting and Analyzing Data and Communicating Findings highlight key weaknesses in the scientific process—namely, the ability to draw insights from data and effectively present results. This under-performance suggests a fragmented understanding of the scientific method, where learners might engage in inquiry superficially without internalizing critical steps.

These findings call for deliberate efforts by science educators and curriculum planners to enhance students' scientific inquiry skills. Teachers should adopt structured, inquiry-based learning strategies that immerse learners in hands-on experimentation, problem-solving, and critical thinking. Specific interventions may include scaffolded laboratory activities that focus on data analysis and interpretation, as well as reflective tasks such as science journaling and peer presentations to improve communication of findings. Additionally, professional development should be provided to equip teachers with techniques to foster question-driven learning environments. By addressing these specific skill gaps, science instruction can better support the development of scientifically literate students capable of meaningful engagement with real-world problems.

Learners' Performance After the Implementation of Inquiry-Based Instruction

Table 3 presents the learners' performance after the implementation of inquiry-based instruction. The overall mean score (M = 46.08) falls under the outstanding category, indicating a substantial improvement in learner performance. The majority of students (n = 13, 52.00%) achieved an outstanding rating, followed by those rated as satisfactory (n = 8, 32.00%). A smaller proportion of learners fell under the fair (n = 2, 8.00%) and poor (n = 2, 8.00%) categories. Notably, no learner was categorized as very poor, which marks a significant shift from the previous performance data.

TABLE 3. Learners' Performance After the Implementation of Inquiry-Based Instruction

Performance	Frequency	Percentage
Outstanding	13	52.00
Satisfactory	8	32.00
Fair	2	8.00
Poor	2	8.00
Overall Performance	46.08	Outstanding

Note: Scale: 47-50 (Outstanding); 44-46 (Very Satisfactory); 42-43 (Satisfactory); 40-41 (Fair); 38-39 (Poor); 37 and below (Very Poor)

The results demonstrate a marked improvement in learners' performance following the application of inquiry-based instruction. A shift from 100% of students rated as very poor in the previous assessment to over half attaining an outstanding rating signifies not only academic progress but also the effectiveness of the instructional strategy. The increase in the number of learners achieving satisfactory and higher categories suggests that inquiry-based learning promoted active engagement, critical thinking, and conceptual understanding. However, the presence of students in the fair and poor categories (16.00% combined) indicates that some learners may still require additional support or that differentiated instruction was not fully optimized during implementation.

The significant improvement in learners' performance implies that inquiry-based instruction can serve as a powerful pedagogical tool in enhancing student learning outcomes in science. School administrators and curriculum developers should consider adopting this approach as a core component of science instruction. To address the remaining performance gaps, educators should implement support mechanisms such as peer mentoring, targeted remediation, and scaffolded learning activities for students still struggling. Moreover, continuous professional development programs focused on inquiry-based methods should be provided to teachers to sustain and further improve these gains. Monitoring and evaluating student progress through formative assessments can help ensure that all learners benefit equitably from this instructional approach.

Learners' Level of Scientific Inquiry Skills After the Implementation of Inquiry-Based Instruction

Table 4 presents the learners' level of scientific inquiry skills after the implementation of inquiry-based instruction. The overall mean score (M = 3.1696, SD = 0.2282) indicates a high level of scientific inquiry skills among learners. Among the five skill areas, the highest mean was in Planning and Carrying Out Investigations (M = 3.3520, SD = 0.2330), followed by Constructing Explanations (M = 3.2880, SD = 0.2651), both of which were rated as very high. The remaining skills—Asking Questions and Defining Problems (M = 3.2480, SD = 0.2104), Collecting and Analyzing Data (M = 3.0480, SD = 0.1939), and Communicating Findings (M = 2.9120, SD = 0.2386)—were all rated as high.

TABLE 4. Learners' Level of Scientific Inquiry Skills After the Implementation of Inquiry-Based Instruction

Variables	Mean	SD	Remarks
Asking Questions and Defining Problems	3.2480	0.2104	High
Planning and Carrying Out Investigations	3.3520	0.2330	Very High
Collecting and Analyzing Data	3.0480	0.1939	High
Constructing Explanations	3.2880	0.2651	Very High
Communicating Findings	2.9120	0.2386	High
Overall	3.1696	0.2282	High

Note: Scale: 3.25-4.00 (Very High); 2.5-3.24 (High); 1.75-2.49 (Low); 1.0-1.74 (Very Low)

The data reflect a significant improvement in learners' scientific inquiry skills following the integration of inquiry-based instruction. Notably, Planning and Carrying Out Investigations and Constructing Explanations reached the very high level, suggesting that learners became more adept at designing experiments and articulating evidence-based conclusions. These improvements imply that students engaged more actively in hands-on, reflective, and analytical processes. Skills like Asking Questions and Defining Problems nearly reached the very high threshold, indicating growth in learners' curiosity and problem-identification capacities. While still within the high category, Collecting and Analyzing Data and Communicating Findings scored slightly lower, suggesting these areas may require continued reinforcement to reach the same level of proficiency.

International Journal of Scientific Engineering and Science
Volume 10, Issue 5, pp. 18-26, 2026. ISSN (Online): 2456-7361

The findings affirm the effectiveness of inquiry-based instruction in developing essential scientific inquiry skills among learners. School leaders and science educators are encouraged to institutionalize this approach within the curriculum to promote deeper scientific understanding. However, the relatively lower scores in Collecting and Analyzing Data and Communicating Findings suggest the need for targeted enrichment activities. Teachers might integrate structured data interpretation exercises, peer-led data discussions, or use visual tools (e.g., graphs and infographics) to strengthen data literacy. Similarly, incorporating more opportunities for oral presentations, science reporting, and collaborative communication projects can enhance students' ability to articulate their findings. Continuous support, reflective learning, and formative feedback will be crucial in sustaining and expanding these gains across all skill domains.

Significant Difference Between Learners' Performance in Science Before and After the Implementation of Inquiry-Based Instruction

Table 5 presents the statistical analysis of the significant difference in learners' performance in science before and after the implementation of inquiry-based instruction. The comparison examines whether the instructional approach led to measurable improvements in student outcomes.

TABLE 5. Significant Difference Between Learners' Performance in Science Before and After the Implementation of Inquiry-Based Instruction

Variables	M	SD	t-value	p-value	Decision
Before the Implementation of Inquiry-Based Instruction	22.40	6.44	18.20	0.000	Significant
After the Implementation of Inquiry-Based Instruction	46.08	3.52			

*Note: Probability Value Scale: **p<0.01 (Highly Significant); *p<0.05 (Significant); *p>0.05 (Significant); p>0.05 (Not Significant)*

The results show a statistically significant difference in the learners' performance before and after the intervention. The mean performance score before the implementation was lower (M = 22.40, SD = 6.44) compared to the mean after implementation (M = 46.08, SD = 3.52), with a corresponding t-value of 18.20 and a highly significant p-value (p = 0.000). This result (r = not specified, p = 0.000) indicates a meaningful improvement in performance and leads to the rejection of the null hypothesis (Ho), confirming that inquiry-based instruction had a positive effect on learners' academic outcomes. There were no variables reported in Table 5 with p-values greater than 0.05, thus no non-significant findings are present in this analysis.

Given the highly significant result (p = 0.000), the data provide strong evidence that inquiry-based instruction substantially improved students' performance in science. The large increase in mean scores, alongside the strong statistical significance, highlights not only the effectiveness of the intervention but also suggests that the traditional teaching methods used previously may have been insufficient in meeting students' learning needs.

The findings have clear implications for educators, school administrators, and curriculum planners. The significant improvement in performance supports the adoption of inquiry-based instruction as a standard practice in science education. School heads are encouraged to provide regular professional development programs to train teachers in implementing inquiry-based learning strategies effectively. Additionally, classroom activities should be designed to promote hands-on experimentation, student-led inquiry, and collaborative problem-solving. Monitoring student progress through both formative and summative assessments will help sustain the gains observed. Finally, school policies should support innovation in pedagogy by allocating resources and time for planning and reflective teaching practices that prioritize student engagement and active learning.

Significant Difference Between Learners' Level of Scientific Inquiry Skills Before and After the Implementation of Inquiry-Based Instruction

Table 6 shows the results of statistical tests comparing learners' level of scientific inquiry skills before and after the implementation of inquiry-based instruction across five key skill areas. The analysis aimed to determine whether significant differences occurred as a result of the instructional intervention. All variables in the table demonstrated statistically significant improvements after the implementation of inquiry-based instruction, with Asking Questions and Defining Problems showing a significant difference (t = 18.00, p = 0.000), Planning and Carrying Out Investigations revealing a significant result (t = 7.64, p = 0.000), Collecting and Analyzing Data exhibiting a significant improvement (t = 16.45, p = 0.000), Constructing Explanations yielding a significant difference (t = 9.62, p = 0.000), and Communicating Findings presenting a significant change (t = 9.52, p = 0.000); all p-values (p = 0.000) are below the 0.01 threshold, indicating highly significant results and leading to the rejection of the null hypothesis (Ho) for all skill domains.

TABLE 6. Significant Difference Between Learners' Level of Scientific Inquiry Skills Before and After the Implementation of Inquiry-Based Instruction

Variables	t-value	p-value	Decision
Pre-Asking Questions and Defining Problems Post-Asking Questions and Defining Problems	18.00	0.000	Significant
Pre-Planning and Carrying Out Investigations Post-Planning and Carrying Out Investigations	7.64	0.000	Significant
Pre-Collecting and Analyzing Data Post-Collecting and Analyzing Data	16.45	0.000	Significant
Pre-Constructing Explanations Post-Constructing Explanations	9.62	0.000	Significant
Pre-Communicating Findings Post-Communicating Findings	9.52	0.000	Significant

*Note: Probability Value Scale: **p<0.01 (Highly Significant); *p<0.05 (Significant); *p>0.05 (Significant); p>0.05 (Not Significant)*

The consistent statistical significance across all five skill areas suggests that the inquiry-based instruction had a profound and comprehensive impact on students' scientific inquiry abilities. The strongest effects were seen in Asking Questions and Defining Problems and Collecting and Analyzing Data, which are foundational to initiating and sustaining scientific investigations. The results imply that learners became more confident and capable in formulating questions, designing and carrying out investigations, analyzing evidence, constructing logical explanations, and communicating their results effectively. The shift from low to high or very high levels, as previously shown in Tables 2 and 4, aligns well with these significant statistical outcomes.

These findings underscore the value of integrating inquiry-based instruction into science education to foster higher-order thinking and practical inquiry skills. School administrators and curriculum developers should promote and support professional learning communities focused on inquiry-based pedagogy. Teachers can benefit from workshops, lesson study sessions, and instructional coaching that emphasize the use of student-driven investigations and reflective learning practices. To further strengthen students' inquiry competencies, schools may organize science inquiry fairs, data analysis clinics, and peer feedback activities, allowing students to apply and refine their skills in authentic contexts. The alignment between instructional practices and assessment of inquiry skills should also be prioritized to maintain continuous growth and meaningful learning outcomes.

IV. Summary, Findings, Conclusion, And Recommendations

Summary

This study determined the use of inquiry-based instruction in enhancing students' performance, critical thinking, and higher-order thinking skills in science among college students taking science related course at one of the higher education institutions in Ozamiz City, Misamis Occidental, during the School Year 2024–2025. It sought to answer the following specific questions: (1) What is the learners' science performance before the implementation of inquiry-based instruction? (2) What is the learners' level of critical thinking and scientific inquiry skills before the implementation of inquiry-based instruction? (3) What is the learners' performance after the implementation of inquiry-based instruction? (4) What is the learners' level of critical thinking and scientific inquiry skills skills after the implementation of inquiry-based instruction? (5) Is there a significant difference in the learners' performance in science before and after the implementation of inquiry-based instruction? (6) Is there a significant difference in the learners' level of critical thinking and scientific inquiry skills before and after the implementation of inquiry-based instruction?

A one-group pretest-posttest design was employed to evaluate the effects of inquiry-based instruction on students' science performance and scientific inquiry skills. A purposive sampling technique was used to select a single section of college students. The statistical tools used for data analysis were the mean, standard deviation, and t-test.

Findings

The following were the salient findings of this study:

1. Before the implementation of Inquiry-Based Instruction (IBI), learners demonstrated very poor performance in science.
2. Learners exhibited a low level of scientific inquiry skills across all areas prior to the intervention.
3. After the use of IBI, most learners achieved an outstanding level of performance in science.
4. Scientific inquiry skills improved from low to high, with certain areas reaching a very high level following the intervention.
5. There was a highly significant improvement in learners' performance in science after the implementation of inquiry-based instruction.
6. Learners' scientific inquiry skills significantly improved across all five indicators—Defining Problems, Carrying Out Investigations, Analyzing Data, Constructing Explanations, and Communicating Findings—after the intervention.

Conclusions

Learners need active and engaging strategies to overcome poor performance in science, as their initial low level of scientific inquiry skills suggests limited opportunities to explore and investigate scientific concepts. Inquiry-based instruction has proven to be effective in elevating learners' academic performance in science by promoting structured, student-centered learning that strengthens the development of scientific inquiry skills. This approach brings about a substantial and meaningful impact on science achievement, with all aspects of scientific inquiry skills responding positively to inquiry-based learning.

Recommendations

Based on the findings and conclusions, the following are recommended:

1. Adopt inquiry-based instructional approaches that encourage exploration, questioning, and hands-on learning to enhance students' conceptual understanding and scientific proficiency.
2. Design classroom activities that develop learners' critical thinking and higher-order thinking skills through inquiry-based tasks that promote analysis, evaluation, and synthesis.
3. Support the integration of inquiry-based learning into the curriculum by developing standards and providing teaching frameworks that emphasize inquiry and investigation.
4. Provide ongoing professional development and training programs to equip science teachers with strategies and resources necessary for the effective implementation of inquiry-based instruction.
5. Integrate discussions on inquiry-based strategies into Learning Action Cell (LAC) sessions to promote best practices and foster a culture of reflective teaching.
6. Take active roles in the learning process, participate in scientific inquiries, and engage in self-directed learning to build deeper understanding and lifelong thinking skills.

7. Explore the long-term effects of inquiry-based instruction on student performance across different learning areas and identify other variables that may influence its effectiveness.

ACKNOWLEDGMENT

The researcher extends heartfelt gratitude to the following individuals and entities whose support, guidance, and contributions were vital in completing this research endeavor:

The Almighty Father, for the gift of wisdom, strength, and all the blessings bestowed throughout this research journey;

Dr. Genelyn R. Baluyos, Dean of the College of Education and research instructor, for her invaluable guidance, patience, and encouragement in leading the researcher step by step through the process of this study;

Mr. Jame S. Bazar, the research adviser, for his insightful feedback and generous sharing of knowledge, which significantly enriched and refined the study;

Dr. Analyn S. Clarin, Dr. Genelyn R. Baluyos, and Ms. Winlab Jobelle Generalao, for their constructive comments, suggestions, and recommendations during the research final defense

Ms. Myrose Jumawan, the statistician, for her dedication, time, and expertise in the statistical treatment and analysis of the data;

Mrs. Emily C. Cadelina, for graciously permitting the conduct of the intervention in her class and for her support throughout the study;

To the respondents, for their cooperation, time, and willingness to participate in the classes and assessments involved in the research;

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