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Inquiry-Based Instruction in Science among Grade 8 Students in Rizal National High School, Surigao City Division

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Abstract

This study aimed to investigate the effectiveness of inquiry-based instruction compared to a conventional approach in enhancing science learning among Grade 8 students. A quasi-experimental design was employed, involving 76 students from Rizal National High School, Surigao City Division, who were divided into control (conventional instruction) and experimental (inquiry-based instruction) groups. The DepEd Caraga Region Sukdanan standard test was utilized to measure academic performance in science before and after the intervention. Data analysis, using weighted mean, standard deviation, t-test, and Analysis of Covariance (ANCOVA), revealed significant improvements in both groups. However, the experimental group, exposed to inquiry-based instruction, exhibited a more pronounced increase in scores (pre-test mean: 15.55 to post-test mean: 32.82) compared to the control group (pre-test mean: 15.32 to post-test mean: 22.18). Both t-tests and ANCOVA confirmed the statistical significance of these gains ($p < 0.05$), with the inquiry-based approach demonstrating a particularly strong impact on student learning outcomes. The findings underscore the potential of inquiry-based instruction as a valuable pedagogical tool for promoting science learning. This approach, which emphasizes student-centered exploration and discovery, appears to foster a deeper understanding of scientific concepts compared to traditional methods. The study suggests that integrating inquiry-based strategies into science curricula can significantly enhance student achievement and engagement.

Keywords: Inquiry-Based Instruction, Science Education, Quasi-Experimental Study, Student Achievement, Conventional Approach

1. Introduction

In the ever-evolving field of education, effectively teaching all learning competencies within the curriculum, as set by the Department of Education, remains a persistent challenge. Education in the 21st century demands progress and innovation (Magulod, 2017), with learners needing to develop critical thinking skills to thrive in the modern world (Hine et al., 2018). Inquiry-based science instruction has emerged as a promising approach to enhance academic achievement. Despite its frequent use in public secondary schools, research highlights the need for increased teacher support and training to implement this strategy effectively (Bautista, 2023).

Inquiry-based science instruction adopts an investigative approach to teaching and learning, empowering students to actively research problems, explore solutions, make observations, and develop critical thinking skills (Yuliati et al., 2018). It fosters a culture of curiosity, encouraging students to pose probing questions and seek information, essential elements of self-directed learning (Garcia & Paloma, 2018). By emphasizing evidence-based reasoning, inquiry-based science further challenges students to think critically and defend their conclusions (Lopez, 2021). Teachers play a crucial role in facilitating this process, encouraging students to question their conceptual understanding and grapple with challenging problems that lead to new insights (Bagay et al., 2023).

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The Philippines, like many countries, faces obstacles in improving science education. However, inquiry-based learning offers a potential solution. This student-centered approach supports teachers in lesson planning and addressing individual needs by focusing on students' questions, ideas, and reflections (Mulyeni et al., 2019). It addresses prevalent academic performance issues in the Surigao City Division, including low scores, poor conceptual understanding, and lack of motivation. Aligned with constructivist principles, inquiry-based instruction emphasizes active learning, practical experiences, and collaborative inquiry. The challenges observed at Rizal National High School, where students struggle with problem identification and solution development, further highlight the need for inquiry-based learning in science education.

Statement of the Problem

The study wants to know if inquiry-based instruction can help in enhancing academic achievement in science among Grade 8 students in Rizal National High School, Surigao City Division.

The study specifically sought to answer the following questions:

1. What are the test results of the respondents in terms of:

1.1 Conventional (Pre-test & Posttest)

1.2 Experimental (Pre-test & Posttest)

2. Is there a significant difference between pre-test and post-test:

2.1 Experimental Group

2.2 Conventional Group

3. Is there a significant difference between the gain score of the experimental and control group when exposed to inquiry-based instruction and the conventional instruction mode?

4. Based on the findings of the study, what learning materials may be developed?

Hypothesis

At 0.05 level of significance, it is hypothesized that:

Ho1: There is no significant difference between pre-test and post-test of: Experimental (Pre-test & Posttest); and Conventional (Pre-test & Posttest).

Ho2: There is no significant difference between the gain score of the experimental and control group when exposed to inquiry-based instruction and the conventional instruction mode.

2. Literature Review

Impact on Academic Achievement

A meta-analysis and systematic review of the effectiveness of inquiry-based learning found that it engages students in the processes of scientific discovery and can make science relevant to their real-world concerns, leading to strong increases in student engagement, motivation, and academic achievement with long-term knowledge retention (Wilson, 2020). Research on the impact of inquiry-based learning on students' academic achievement in science has shown positive and direct relationships between inquiry-based learning and student achievement (Cairns, 2019). Existing studies have identified various impacts of inquiry-based learning in the science classroom, including its positive relationship with student motivation and long-term knowledge retention (Archer-Kuhn et al., 2020).

Additionally, one study concentrated on how inquiry-based learning affected students' academic performance in scientific classes. Fifth-grade students participated in the study, and it was discovered that those who got teaching through inquiry-based learning fared better than those who received traditional instruction (Ahn & Kang, 2018). In comparison to traditional teaching approaches, the study found that inquiry-based instruction accompanied by the 5E learning cycle method resulted in higher academic accomplishment (Bioco, & Echaure, 2021). Furthermore, studies have shown how crucial inquiry-based learning is to getting children excited about learning science and involved in the process. Further evidence of the beneficial effects of inquiry-based teaching tactics on academic achievement comes from the discovery that these techniques can engage pupils in science (Wale & Bishaw, 2020).

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Teacher Preparation and Professional Development

The literature on teacher preparation and professional development for inquiry-based instruction in science education highlights the importance of equipping teachers with the knowledge and skills necessary to effectively implement inquiry-based teaching strategies (Baker & Robinson, 2018). To help students comprehend and use inquiry to learn science, the National Academies Press highlights the necessity for teachers to be knowledgeable about inquiry and inquiry-based methodologies (Archer-Kuhn et al., 2020). But a lot of teachers haven't had the chance to understand science by doing or leading scientific investigations themselves. In order to effectively create and apply inquiry-based solutions, professional development is therefore essential for both aspiring and experienced teachers (Vallerio et al., 2023). Furthermore, research on inquiry-based writing instruction in academic writing skills highlights the need for teachers to comprehend the nature and application of inquiry-based instruction (Irwanto et al., 2018). The study also emphasizes the significance of teachers using inquiry-based writing instruction to support students in continuously assessing their learning and reflecting on it in the classroom, with the teacher offering scaffolding and introducing pertinent concepts, principles, and theories to facilitate students' deeper understanding of academic writing skills through inquiry (Darling-Hammond et al., 2020). Lastly, research on the inquiry-based approach in teaching probability among students emphasizes the necessity of teachers utilizing inquiry-based learning to engage students in the process of learning and elicit enthusiasm in science education. The study emphasizes that teachers need to employ inquiry-based teaching strategies to effectively stimulate excitement among students when learning science (Legaspi et al., 2020).

Inquiry-based Instruction

Furthermore, research on inquiry-based writing instruction in academic writing skills highlights the need for teachers to comprehend the nature and application of inquiry-based instruction (Irwanto et al., 2018). The study also emphasizes the significance of teachers using inquiry-based writing instruction to support students in continuously assessing their learning and reflecting on it in the classroom, with the teacher offering scaffolding and introducing pertinent concepts, principles, and theories to facilitate students' deeper understanding of academic writing skills through inquiry (Darling-Hammond et al., 2020). Lastly, research on the inquiry-based approach in teaching probability among students emphasizes the necessity of teachers utilizing inquiry-based learning to engage students in the process of learning and elicit enthusiasm in science education.

Inquiry-based instruction in science education is an approach that encourages students to engage in the processes of scientific discovery and makes science relevant to their real-world concerns. This teaching method has been shown to have a positive impact on student achievement, motivation, and long-term knowledge retention (Ahn & Kang, 2018). It involves students making observations, asking questions, conducting experiments, and finding answers, making science more engaging and fun (Heick, 2019). Inquiry-based learning also helps students develop critical thinking, problem-solving, and communication skills, which are essential for success in both scientific and non-scientific fields (Tawfik et al., 2020).

According to Yuliati et al. (2018), science education should emphasize teaching students about science's beauty as well as how scientific knowledge is produced, in addition to training them to be future scientists and engineers. Teachers require professional development and support in order to successfully implement inquiry-based instruction in science education. This includes learning about the nature of inquiry-based learning, mastering the teaching of non-prescriptive inquiry, and taking part in pertinent workshops and training (Lopez, 2021). Additionally, working together and exchanging experiences and difficulties in putting inquiry-based learning into practice in the classroom can be beneficial for educators (Bioco, & Echaure, 2021).

Inquiry-Based Instruction in Enhancing Academic Achievement in Science

The efficacy of inquiry-based instruction as a pedagogical strategy in science education is becoming more widely acknowledged, particularly with regard to improving students' comprehension and performance. With the use of inquiry, research, and critical thinking, students actively engage in the learning process as part of this method's emphasis on student-centered learning. Several research have shown that inquiry-based learning improves students' academic performance in science (Krajcik & Blumenfeld, 2021).

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One significant advantage of inquiry-based instruction is its ability to foster deeper understanding and retention of scientific concepts. For instance, a study by Pedaste et al., (2020), highlighted that students engaged in inquiry-based learning exhibited better comprehension and application of scientific knowledge compared to those taught through traditional methods. This deeper understanding is attributed to the active engagement and hands-on experiences that are central to inquiry-based learning. Furthermore, inquiry-based instruction has been shown to improve students' critical thinking and problem-solving skills. According to Bell et al., (2019), students who participated in inquiry-based science lessons developed superior analytical skills, which are crucial for scientific inquiry and real-world problem-solving. This improvement in critical thinking abilities is essential for students to navigate and succeed in increasingly complex scientific landscapes (Crawford, 2020).

Students who get inquiry-based learning have more positive attitudes toward science, which improves their academic achievement. Because it can be adjusted to fit different learning styles, scientific education can become more inclusive (Minner et al., 2010). Using group activities, it also strengthens cooperation and communication abilities. However, there are obstacles to putting inquiry-based learning into practice, like resource availability and teacher preparation. In order to create learning environments that are conducive to learning, instructors must have sufficient resources and support. They must also be informed about managing dynamic classroom environments and student-centered learning (Furtak et al., 2012).

Challenges that Teachers Face in Implementing Inquiry-Based Instruction

When implementing inquiry-based instruction in science education, teachers encounter a number of difficulties. Measuring the effectiveness of inquiry as it is applied in the classroom is a significant difficulty. This entails evaluating inquiry-based instruction's efficacy and gauging how effectively students are connecting with the subject matter (Darling-Hammond et al., 2020). Teachers also have difficulty managing an inquiry-based classroom, thinking of content and inquiry as complimentary components of the same aim, and employing discourse and conversation to promote more successful inquiry-based learning (Bautista, 2023).

Furthermore, teachers may resort to direct instruction in order to effectively impart scientific information to pupils because of the pressure of high-stakes testing and curricular standards, which occasionally prioritize breadth over depth (Wale & Bishaw, 2020). The fear of losing control in an inquiry-based classroom—including control over instruction, students, and the class—is another major worry for teachers. This anxiety can make it difficult to implement inquiry-based education (Ligado et al., 2022). Professional growth, peer cooperation, and modification of inquiry-based teaching strategies to better meet the requirements and learning preferences of students are necessary to overcome these obstacles (Bagay et al., 2023).

Local Studies on Inquiry-Based Instruction

The Philippines has advocated for and implemented inquiry-based teaching; however, there are obstacles to its implementation, such as a deficiency of resources, training, and support; a focus on content learning assessments rather than inquiry-based learning; and the complexity and time-consuming nature of inquiry approaches (Wale & Bishaw, 2020). Inquiry-based learning has been shown to improve EFL students' critical thinking abilities. It also has the potential to foster lifelong learning and the development of higher-order thinking skills, according to a research published in the Asian-Pacific Journal of Second and Foreign Language Education. Unfortunately, no local research has been done to find out how inquiry-based writing teaching works in an EFL setting (Attard, Berger, & Mackenzie, 2021). Despite these challenges, efforts are being made to address them through professional development models such as lesson study, which aims to build sustainable, collaborative, and reflective professional development for in-service teachers (Wilson, 2020).

Enhanced Understanding and Retention of Scientific Concepts

Inquiry-based instruction (IBI) involves students actively in the learning process, which improves their understanding and recall of scientific concepts (Pedaste et al., 2020). Long-term memory retention and meaningful learning are encouraged by this method. IBI encourages higher-order thinking through experiments, inquiries, and data interpretation, which also helps to develop critical thinking and problem-solving abilities. These critical skills are further enhanced by the iterative nature of inquiry (Bell et al., 2019). IBI can meet the demands of a wide range of students and is naturally adaptive to various learning methods. According to Minner et al. (2010), IBI enables a variety of activities that can be customized to meet the individual interests and skill levels of each student. Because of its adaptability, science education is more inclusive and allows students from all backgrounds to interact effectively with the material. IBI fosters equity in the classroom and aids in closing success disparities by attending to each student's unique learning needs.

Theories Related to the Study

Inquiry-based science instruction is a pedagogical approach where students actively participate in learning through hands-on experiences and investigations. Theories like Constructivism, which posits that learners construct knowledge through their experiences (McNeill, 2018), underpin this approach.

Cognitive Load Theory, which guides the design of appropriately challenging activities, helps manage students' cognitive load and optimize learning outcomes (Ligado et al., 2022). Social Learning Theory emphasizes collaborative learning, where students gain knowledge and perspectives from each other (Bioco & Echaure, 2021). The Zone of Proximal Development (ZPD) theory further supports this approach by scaffolding learning experiences to match student abilities (Bioco & Echaure, 2021).

Self-Determination Theory emphasizes the role of autonomy in learning, and inquiry-based learning provides this autonomy, fostering competence and intrinsic motivation (Irwanto et al., 2018). Lastly, Bloom's Taxonomy highlights the development of higher-order thinking skills like analysis, evaluation, and creation, which are integral to inquiry-based learning (Discipulo & Bautista, 2022).

3. Methodology

This study utilized a mixed-methods approach, incorporating both descriptive-comparative and quasi-experimental pre-test and post-test designs. The descriptive-comparative design was employed to determine if there were significant differences in student academic performance in science before and after the intervention. The quasi-experimental design, suited for natural settings, was used to compare the test scores of conventional and experimental groups before and after instruction.

The study participants were Grade 8 students at Rizal National High School who had not yet acquired specific learning competencies in science. A purposive sampling method was used to select 76 students, divided equally into a control group (conventional approach) and an experimental group (inquiry-based instruction).

Data collection involved obtaining necessary approvals from the Surigao City School Division Superintendent and the school principal. The study was conducted during the third quarter of the 2023-2024 school year. Both groups were given a pre-test before instruction, followed by teaching using either conventional or inquiry-based methods based on the Department of Education's curriculum guide. Post-tests were administered after the intervention.

Data analysis was performed using weighted mean, standard deviation, t-test, and ANCOVA. Weighted mean and standard deviation assessed the effectiveness of inquiry-based instruction on academic performance. The t-test determined significant differences between pre- and post-test scores for both groups. ANCOVA tested for group differences while controlling for variance.

This comprehensive approach allowed the researchers to thoroughly examine the impact of inquiry-based instruction on students' science learning and compare its effectiveness to traditional teaching methods.

4. Results and Discussions

The table below shows answers to the problems given in the research questions.

Table 1.1. Test Results of the Respondents in terms of Conventional (Pre-test & Posttest)

Conventional	PRE-TEST					POSTTEST				
	Mean	SD	Grading	Qualitative	Verbal	Mean	SD	Grading	Qualitative	Verbal

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Approach			Scale	Description	Interpretation			Scale	Description	Interpretation
	15.32	4.485	Passed	Fairly Satisfactory	Low Progress	22.18	6.008	Passed	Satisfactory	Average Progress

Legend: 0 – 9.99 (Did not meet expectations); 10 – 19.99 (Fairly Satisfactory); 20 – 29.99 (Satisfactory); 30 – 39.99 (Very Satisfactory); 40 – 50.00 (Outstanding)

Table 1.1 provides insights into student performance under a conventional teaching approach, comparing pre-and post-test results. Initially, students demonstrated a "Low Progress" level of understanding, with a mean score of 15.32 categorized as "Fairly Satisfactory." However, following the intervention, their performance improved to an "Average Progress" level, reflected in a mean score of 22.18, considered "Satisfactory." While this improvement is positive, it underscores the limitations of the conventional approach in fostering substantial conceptual grasp. To achieve higher levels of student learning, additional interventions or alternative teaching methods might be necessary.

Table 1.2. Test Results of the Respondents in terms of Experimental (Pre-test & Posttest)

Experimental Approach	**PRE-TEST**					**POSTTEST**				
	Mean	**SD**	**Grading Scale**	**Qualitative Description**	**Verbal Interpretation**	**Mean**	**SD**	**Grading Scale**	**Qualitative Description**	**Verbal Interpretation**
	15.55	4.440	Passed	Fairly Satisfactory	Low Progress	32.82	5.417	Passed	Very Satisfactory	Above Average Progress

Legend: 0 – 9.99 (Did not meet expectations); 10 – 19.99 (Fairly Satisfactory); 20 – 29.99 (Satisfactory); 30 – 39.99 (Very Satisfactory); 40 – 50.00 (Outstanding)

Table 1.2 illustrates a remarkable improvement in student performance following the implementation of an experimental approach. Pre-test scores indicated "Low Progress" with a "Fairly Satisfactory" mean score, but post-test scores jumped significantly to "Very Satisfactory," reflecting "Above Average Progress." This suggests the experimental approach was highly effective in enhancing understanding. While these initial results are promising, more data is needed to confirm its superiority over traditional methods. Further research should include a larger sample size, statistical analysis, comparison with a control group, and long-term assessment. However, this preliminary evidence strongly supports the potential of the experimental approach in promoting learning.

Table 2. Significant Difference between Pre-test and Post-test in terms of Experimental Group and Conventional Group

Groups	**Mean Difference**	**Computed t**	**p-level**	**Decision on H_o**	**Interpretation**
Conventional	6.868	-9.402	.000	Reject H_o	Significant
Experimental	17.263	-15.159	.000	Reject H_o	Significant

Significance at $p < 0.05$

Table 2 presents statistical evidence strongly suggesting that the experimental approach led to significantly greater changes compared to the conventional approach. This difference is highly unlikely to be due to chance. While we can't pinpoint the exact nature of the study from this table alone, it's clear that the experimental intervention was more impactful. However, determining the practical implications requires further analysis and consideration of effect sizes within the study's specific context. Future research is needed to fully understand the benefits and applications of the experimental approach.

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Table 3. Significant Difference Between the Gain Score of the Experimental and Control Group When Exposed to Inquiry-Based Instruction and the Conventional Instruction Mode

Groups	Mean Difference	Computed f	p-level	Decision	Interpretation
Control	6.868	24.325	2.21E-07	Reject Ho	Significant
Experimental	17.263				
Pretest		0.046	0.234	Accept Ho	Not Significant

The results indicate a significant difference in performance between the control and experimental groups, favoring the latter. The lack of a significant effect from the pre-test suggests that the inquiry-based approach, rather than prior knowledge, was responsible for this improvement. The experimental group's higher mean difference (10.395) further supports the effectiveness of inquiry-based learning (IBL) in enhancing critical thinking, problem-solving, and knowledge retention, aligning with research by Saulnier and Kramer (2021) and Furtak et al. (2020). In conclusion, IBL proves more effective than traditional teaching for Grade 8 science students. It fosters greater knowledge acquisition, improved skills, and increased confidence in sharing ideas. The researchers recommend IBL's broader application across learning areas.

5. Conclusion

This study highlights the significant impact of inquiry-based learning on students' science comprehension. Initial pre-test results revealed both the control and experimental groups struggled with the subject matter. However, the post-test showed a dramatic improvement in the group exposed to inquiry-based learning, achieving "Above Average Progress" compared to the "Average Progress" of the traditional teaching group. This statistically significant finding strongly supports the effectiveness of inquiry-based learning in fostering deeper understanding and knowledge retention. It challenges conventional teaching methods, advocating for a more student-centered approach that empowers learners to actively construct their own knowledge. While further research is needed to explore its long-term impact and applicability across various contexts, this study provides compelling evidence for the transformative potential of inquiry-based learning in science education. By embracing this approach, we can cultivate a generation of scientifically literate and curious individuals.

6. Recommendations

Based on the study's positive outcomes, it is strongly recommended that educators adopt inquiry-based learning in their classrooms. This student-centered approach, which encourages active exploration and discovery, has shown significant potential in enhancing science education. To facilitate this transition, it is essential to provide comprehensive professional development programs for teachers. These programs should equip educators with the skills and knowledge necessary to design and implement effective inquiry-based lessons. Likewise, systemic shift towards inquiry-based learning is crucial. This requires curriculum reform that prioritizes inquiry-based approaches at all grade levels. Furthermore, adequate resource allocation is vital to ensure schools have the necessary tools and materials to support hands-on investigations and scientific exploration. Finally, continued research is necessary to fully understand the long-term impact and potential of inquiry-based learning. Investigating its effects on various aspects of student learning will allow us to unlock its full potential and create a more transformative science education experience.

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