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Predictive Influence of Innovative Science Teaching Strategies on the Academic Performance of Grade 11 Students in Science

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ABSTRACT

This study explored the predictive influence of innovative science teaching strategies on the academic performance of Grade 11 students in science. Specifically, it investigated the level of implementation of inquiry-based learning, project-based learning, technology integration, collaborative learning, and formative assessment and feedback. Employing a quantitative predictive-correlational research design, data were collected from 194 students using a validated survey questionnaire and analyzed using descriptive statistics, correlation, and multiple regression analysis. Findings showed that these strategies were generally well to very well implemented, contributing to an engaging and supportive learning environment. Student performance was notably high, with more than half achieving outstanding grades. Correlation results indicated that ICT integration and formative assessment had strong and significant positive relationships with science achievement, while inquiry-based, project-based, and collaborative learning showed negligible associations. Multiple regression analysis confirmed that ICT integration, inquiry-based learning, and assessment practices significantly predicted science performance, with ICT demonstrating the strongest effect. Overall, the study highlights that structured guidance, effective use of technology, and consistent feedback are key contributors to improved science learning outcomes. These results emphasize the importance of strengthening technology use and assessment practices to support student success in secondary science education.

Keywords: innovative teaching strategies, science performance, ICT integration, formative assessment, inquiry-based learning, project-based learning, collaborative learning

INTRODUCTION

Background of the Study

Science and technology continue to advance rapidly, requiring educational systems to prepare learners who are capable of critical thinking, problem-solving, and innovation. In contemporary science education, it is no longer sufficient for students to merely memorize concepts; they must also be able to apply these ideas to real-life situations. As a result, teaching practices have shifted from traditional teacher-centered approaches toward more student-centered methods that promote active engagement and deeper learning. This shift is grounded in the principle that meaningful learning occurs when students construct knowledge through questioning, collaboration, experimentation, and reflection. Globally, educators continue to explore effective approaches to improve science instruction, particularly as international standards increase and the demand for science-related competencies becomes more pronounced.

Despite these developments, many students still encounter difficulties in learning science. Research indicates that learners often struggle to understand complex concepts, retain information, and transfer knowledge to new contexts. These challenges are commonly associated with persistent misconceptions, limited opportunities for hands-on experiences, and the continued use of teaching strategies that do not encourage active thinking (Salvacion, 2025). Traditional lecture-based instruction remains prevalent in many classrooms; however, it tends to limit student interaction with content, peers, and teachers. Consequently, there is a growing emphasis on the adoption of innovative teaching strategies such as inquiry-based learning, project- and problem-based learning, digital simulations, cooperative learning, and hands-on activities to enhance the quality of science education.

Inquiry-based learning enables students to explore scientific concepts through questioning, observation, experimentation, and evidence-based reasoning (Anderson, 2021). This approach supports the development of deeper conceptual understanding and strengthens scientific thinking skills. Similarly, project- and problem-based learning situate knowledge within real-world contexts, allowing students to engage in meaningful tasks that require collaboration and critical thinking. These approaches have been shown to improve student engagement and retention of knowledge (Lee & Chen, 2022). In addition, the integration of technology—such as virtual laboratories, simulations, and multimedia resources—facilitates the visualization of abstract scientific concepts and supports self-paced learning (Torres & Fernandez, 2024).

Collaborative learning also plays a significant role in modern science instruction. Through group work, peer discussions, and shared problem-solving tasks, students can exchange ideas, address misconceptions, and develop both cognitive and social skills (Cruz & Reyes, 2023). Furthermore, hands-on learning experiences, including laboratory experiments and field activities, remain essential components of effective science teaching. These experiences allow students to directly engage with scientific phenomena, apply theoretical knowledge, and develop investigative skills. Research consistently demonstrates that students who participate in regular laboratory activities tend to perform better in science (McLaren & Howe, 2025).

Although the benefits of these innovative strategies are well documented, their implementation presents several challenges. Teachers may face constraints related to limited training, insufficient resources, and time limitations. In addition, large class sizes and limited access to technological tools may hinder effective implementation. The success of these strategies may also vary depending on student characteristics, school context, and available support systems. While many studies have examined individual teaching strategies, relatively few have explored how these approaches collectively influence student performance, particularly within specific educational settings. Moreover, there remains limited evidence regarding the predictive influence of these strategies on academic achievement.

Recent studies have attempted to address these gaps; however, findings remain inconsistent. For instance, Enriquez and Santos (2023) reported that inquiry-based learning significantly predicted improved science performance, although its effectiveness depended on the consistency of implementation. Similarly, Panganiban (2024) found that digital simulations enhanced conceptual understanding, but their impact on overall academic performance was moderate. Research on project- and problem-based learning has produced mixed results, with effectiveness varying depending on the duration of implementation and assessment design (Delos Reyes & Huang, 2025). These variations highlight the need for further investigation into how multiple teaching strategies interact to influence student performance.

Furthermore, much of the existing research has been conducted in well-resourced educational environments characterized by advanced laboratory facilities, stable internet access, and extensive teacher training. Such conditions may not accurately represent many public secondary schools, particularly those in rural or resource-constrained areas. In these contexts, limitations in instructional materials, overcrowded classrooms, and restricted professional development opportunities may influence the effectiveness of innovative teaching strategies. Therefore, it is essential to examine how these approaches function within local educational settings to determine their practical applicability and impact.

Considering these considerations, this study aims to investigate the predictive influence of selected innovative science teaching strategies on the academic performance of Grade 11 students. Specifically, it focuses on inquiry-based learning, project- and problem-based learning, ICT integration, collaborative learning, and formative assessment and feedback. By examining these strategies collectively rather than in isolation, the study seeks to identify which approaches significantly contribute to improved academic outcomes in science.

The findings of this study are expected to contribute to the existing body of knowledge by providing empirical evidence on the effectiveness of innovative teaching strategies in a real-world context. In addition, the results may inform instructional practices, support curriculum development, and guide decision-making among educators and school administrators. Ultimately, the study aims to promote more effective science teaching practices that enhance student learning and academic achievement.

Statement of the Problem

This study aimed to determine the predictive influence of innovative science teaching strategies to the science academic performance of Grade 11 students at Llorente National High School. Specifically, it sought to answer the following key questions.

1. What is the level of implementation of each innovative science teaching strategies as perceived by the students?

1.1. Inquiry-based Learning

1.2. Project- and Problem-Based Learning

1.3. ICT Integration

1.4. Collaborative and Peer Learning

1.5. Formative Assessment and Feedback

2. What is the academic performance of the Grade 11 students in science based on their semester final grade?

3. Is there a significant relationship between innovative teaching strategies and students' academic performance?

4. Which teaching strategies significantly predict students' academic performance?

METHODOLOGY

Research Design

This study employed a descriptive-correlational research design to examine the relationship between innovative science teaching strategies and the academic performance of Grade 11 students. This design was appropriate because it allowed for the systematic investigation of variables as they naturally occur, without manipulation or experimental intervention.

The descriptive component was used to determine the extent to which selected innovative teaching strategies—namely inquiry-based learning, project-and problem-based learning, information and communication technology (ICT) integration, collaborative learning, and formative assessment and feedback were implemented in the classroom. It also described the level of students' academic performance in science.

The correlational component assessed the relationships between the identified teaching strategies and students' academic performance. In addition, multiple regression analysis was utilized to determine the predictive influence of these strategies when considered collectively. This approach enabled the identification of which teaching strategies significantly contributed to variations in students' performance.

Data were collected using a structured survey questionnaire to measure the extent of strategy implementation, along with students' academic records to determine performance levels. The use of validated instruments and appropriate statistical tools ensured the reliability and accuracy of the findings.

Overall, the chosen research design provided a clear and efficient framework for analyzing both the individual and combined effects of innovative teaching strategies on students' academic outcomes

Research Locale

While this study provides valuable insights into the implementation and effects of innovative science teaching strategies, it was conducted at a single site—Llorente National High School in Llorente, Eastern Samar which may limit the generalizability of the findings. The school is a large public secondary institution offering both Junior and Senior High School programs and serving students from the town proper as well as nearby barangays. It was selected as the research site due to its active science program, the implementation of a variety of innovative teaching strategies in classrooms, the accessibility of the institution, and the support provided by the school administration. The study was conducted at a public secondary school offering Senior High School education. The institution provides academic tracks, including the Science, Technology, Engineering, and Mathematics (STEM) strand, which emphasizes the development of scientific knowledge and skills among learners. The school was selected due to its accessibility, the presence of Grade 11 students enrolled in science subjects, and the implementation of innovative teaching strategies by science teachers.

The school environment reflects typical conditions in public secondary schools, including varied class sizes, limited instructional resources, and diverse student backgrounds. These characteristics make the locale suitable for examining the effectiveness of innovative science teaching strategies in a real-world educational setting.

Despite these advantages, the context-specific nature of the study may limit the applicability of the findings to schools with different demographic profiles, institutional structures, or levels of resource availability. Therefore, future research is encouraged to include multiple schools across diverse settings such as urban and rural institutions, as well as schools with varying levels of access to technology to enhance external validity and provide a broader understanding of how innovative teaching strategies influence science performance.

Respondents of the Study

The respondents of the study were 194 Grade 11 students enrolled in science subjects during the academic year. These students were selected because they are directly exposed to various teaching strategies employed in science instruction and can provide relevant data regarding their learning experiences.

The participants represented a range of academic abilities and backgrounds, ensuring variability in responses. Their inclusion allowed for a comprehensive assessment of how innovative teaching strategies relate to academic performance in science.

Sampling Procedure

The study employed a proportionate random sampling technique to determine the number of respondents selected from each Grade 11 section. This method ensured that each section was represented in the sample according to its population size, thereby improving the overall representativeness of the study. Proportionate random sampling is a type of probability sampling in which the population is divided into distinct subgroups or strata that share a common characteristic—in this case, the Grade 11 sections. Respondents are then randomly selected from each stratum in proportion to its size within the total population.

This method was appropriate for the present study because the population of 377 students was distributed across 11 sections with varying class sizes. By applying proportionate allocation, sections with larger enrollments contributed more respondents, while smaller sections contributed fewer participants, maintaining proportional representation. The use of this sampling technique strengthened the validity of the study by ensuring balanced representation while preserving randomness in the selection process. As a result, the findings more accurately reflect the perspectives and experiences of Grade 11 students in the school.

Research Instrument

The study utilized a researcher-made survey questionnaire to collect data on students' perceptions of innovative science teaching strategies, as well as their demographic characteristics. The instrument was structured into two parts. Part A gathered demographic information, including age, sex, section, and final semester grade in science. These data were used to describe the respondents and to examine possible patterns in relation to their perceptions and academic performance. Part B assessed the implementation of five innovative science teaching strategies: inquiry-based learning, project- and problem-based learning, ICT integration, collaborative and peer learning, and formative assessment and feedback. Each construct was measured using five statements, rated on a five-point Likert scale ranging from Strongly Agree to Strongly Disagree.

The items were designed to capture key dimensions of each strategy. Inquiry-based learning focused on opportunities for questioning, investigation, and evidence-based reasoning. Project- and problem-based learning addressed engagement in real-world tasks and the application of scientific concepts. ICT integration examined the use of digital tools, such as simulations, virtual laboratories, and multimedia resources. Collaborative and peer learning measured participation in group activities, discussions, and cooperative tasks. Formative assessment and feedback evaluated the frequency and quality of assessments, including quizzes, peer reviews, and teacher feedback.

To ensure content validity, the questionnaire was reviewed by experts in science education and research. Their feedback was used to refine the items for clarity, relevance, and alignment with the study objectives. A pilot test was subsequently conducted with a small group of Grade 11 students to assess reliability. The internal consistency of the questionnaire was evaluated using Cronbach's alpha. The overall Cronbach's alpha coefficient was 0.87, indicating high reliability of the instrument. This suggests that the items consistently measured the intended constructs, and the instrument was considered both valid and reliable for collecting data on students' perceptions of innovative science teaching strategies.

Data Gathering

The data-gathering procedure employed a systematic approach to capture students' perceptions of innovative science teaching strategies at Llorente National High School. The research instrument was designed to ensure cultural and contextual relevance and underwent rigorous validation through expert review and a pilot test, which strengthened its reliability and validity. Ethical standards were strictly observed, with informed consent obtained from both students and their parents or guardians.

The study targeted Grade 11 students, using a sampling technique that ensured representation across sections and academic strands. Data collection involved administering the validated researcher-made instruments and retrieving students' academic performance records. Semester final grades in science served as the primary indicator of academic achievement. Although these grades provide a standardized measure of performance, they may not fully reflect students' conceptual understanding, critical thinking, or ability to apply scientific knowledge.

Future research could incorporate additional assessment methods—such as standardized tests, performance-based evaluations, laboratory outputs, and concept-based tasks—to provide a more comprehensive evaluation of student learning outcomes. Integrating these measures would allow for a multidimensional understanding of how innovative teaching strategies affect both knowledge acquisition and practical application of scientific concepts.

Analysis of Data

The data analysis in this study on the predictive influence of innovative science teaching strategies on the academic performance of Grade 11 students at Llorente National High School, Eastern Samar, was designed to provide a comprehensive understanding of which strategies most strongly predict student performance in science.

The analysis began with descriptive statistics to summarize students' academic performance and the level of implementation of each innovative science teaching strategy in the classroom. These strategies included inquiry-based learning, project- and problem-based learning, ICT integration, collaborative and peer learning, and formative assessment and feedback. Descriptive statistics provided an overview of how each strategy was employed and the overall performance patterns among students.

Next, correlation analysis examined the strength and direction of relationships between each innovative science teaching strategy and students' science performance. This step identified which strategies were most closely associated with academic outcomes. Finally, multiple linear regression analysis was conducted to determine the predictive power of each strategy and to identify those most strongly linked to students' performance in science.

The interpretation and discussion of results were contextualized within existing literature and relevant theoretical frameworks, highlighting both practical implications for classroom instruction and potential avenues for future research. Overall, the data analysis was rigorous and multifaceted, providing meaningful insights into the relationship between innovative science teaching strategies and students' academic performance in the context of Llorente National High School.

Ethical Considerations

Ethical considerations were central to ensuring the integrity and validity of this research. A primary concern was obtaining informed consent, which is especially important given the participants' age. Explicit consent was obtained from both students and their parents or guardians. The researchers provided clear and comprehensible information about the study's purpose, procedures, and voluntary nature. Participants and their guardians were informed that they could withdraw from the study at any time without any negative consequences.

Confidentiality and privacy were also prioritized. Given the sensitive nature of data on students' experiences with innovative science teaching strategies and their academic performance, all responses were anonymized. Data were stored securely, with access restricted to authorized personnel, ensuring that participants' privacy was protected.

Maintaining objectivity and avoiding bias were further ethical priorities. The researcher took care to prevent personal biases from influencing data collection, analysis, or interpretation. All participants were treated fairly and equally, regardless of their section, academic strand, or background.

Finally, the ethical use of data was strictly observed. All information was used solely for the purposes outlined in the study. Findings were reported accurately and honestly, without manipulation or misrepresentation to support preconceived hypotheses. These measures collectively ensured that the research adhered to ethical standards and respected the rights and well-being of all participants.

RESULTS AND DISCUSSION

Level of Implementation of innovative Science Teaching Strategies

Table 1 presents respondents' assessment of the level of implementation of Inquiry-Based Learning (IBL) in the classroom across five key instructional indicators. The table reports the mean scores, standard deviations, and categorical interpretations, reflecting how frequently and consistently each IBL practice is observed.

Table 1. Level of Implementation of Inquiry Based Learning

Statements	Mean	SD	Interpretation
Classroom activities require students to generate explanations from evidence.	4.40	0.68	Very well implemented
The teacher gives experiments where students design their own procedure and choose variables.	4.09	0.77	Well implemented
The students are guided to discover answers on their own rather than simply given to them by the teacher.	4.05	0.85	Well implemented
The teacher asks questions that make students investigate and test ideas.	3.98	0.86	Well implemented

Students often plan and carry out short investigations during class	3.94	0.80	Well implemented
Total	**4.09**	**0.80**	**Well implemented**

The weighted mean of 4.09 (SD = 0.80) indicates that IBL is generally "well implemented" in the participating classrooms. The highest-rated indicator, "Classroom activities require students to generate explanations from evidence" (Mean = 4.40), suggests that teachers strongly emphasize evidence-based reasoning, a core element of inquiry. Other indicators, such as allowing students to design procedures (Mean = 4.09), guiding independent discovery (Mean = 4.05), and prompting investigations through questioning (Mean = 3.98), also show consistent use of student-centered strategies. Even the lowest-rated indicator, students planning and conducting short investigations (Mean = 3.94), reflects favorable implementation.

These results indicate that teachers integrate inquiry-oriented practices systematically, promoting active participation, exploration, and independent learning. The consistently high means suggest that IBL is embedded in the instructional routines, fostering a learning environment where curiosity, experimentation, and evidence-based thinking are encouraged.

The findings are consistent with previous research emphasizing the benefits of inquiry-based approaches. Furtak et al. (2020) reported that structured inquiry promotes stronger conceptual gains compared to traditional instruction, while Almuntasheri (2020) found that inquiry-based teaching enhances students' reasoning, problem-solving skills, and engagement—consistent with the high student involvement reflected in the table.

The results have several instructional implications. First, the strong implementation of IBL indicates that teachers are creating experiences that foster higher-order thinking, autonomy, and scientific literacy, supporting a shift from rote learning to authentic, process-oriented instruction. Second, the slightly lower rating on students conducting their own investigations highlights an opportunity for schools to provide additional time, resources, and professional development to enrich hands-on inquiry tasks, which may further enhance engagement and academic outcomes.

Table 2 presents the Level of Implementation of Problem and Project-Based Learning (PBL) in a science classroom context. It outlines how various aspects of PBL are executed. It shows mean scores, standard deviations (SD), and an interpretation of implementation level for each statement.

Table 2. Level of Implementation of Problem and Project-Based Learning (PBL)

Statements	Mean	SD	Interpretation
Projects are meaningful and clearly connected to real science problems.	3.68	0.85	Well implemented
Projects require research, planning, and presentation of findings.	3.60	1.02	Well implemented
The students work on real-world projects related to science topics.	3.53	0.81	Well implemented
The teacher asks questions that make students investigate and test ideas.	3.46	0.89	Well implemented
Students often plan and carry out short investigations during class	3.37	0.96	Partially implemented
Total	**3.52**	**0.91**	**Well implemented**

The results indicate that most aspects of Project-Based Learning (PBL) are well implemented, with mean scores ranging from 3.46 to 3.68. Notably, the indicator on projects being meaningful and connected to real scientific problems obtained the highest mean score (3.68), highlighting that teacher effectively link learning activities to authentic scientific contexts. Similarly, projects requiring research, planning, and presentation yielded a high mean of 3.60, demonstrating that students are actively engaged in structured inquiry processes.

In contrast, the indicator concerning students' frequent planning and execution of short investigations during class obtained the lowest mean score (3.37) and was interpreted as only partially implemented. This suggests that opportunities for brief, hands-on investigative activities are less consistently integrated into daily instruction. The overall mean of 3.52 indicates that PBL is generally well implemented in the classroom. However, the relatively lower rating for short investigations implies that while teachers effectively facilitate comprehensive, long-term projects, there may be limited emphasis on continuous, day-to-day inquiry practices.

This finding underscores the need to balance extended project work with shorter investigative exercises to promote sustained student engagement and the continuous development of scientific inquiry skills. As emphasized by Thomas (2020), well-structured project-based learning enhances students' critical thinking and problem-solving abilities in science. Likewise, Bell (2021) reported that real-world project connections significantly increase student motivation and deepen conceptual understanding. However, Strobel and van Barneveld (2020) noted that inconsistent implementation of short-term investigations may hinder the development of continuous inquiry skills.

Overall, while the school demonstrates effective implementation of PBL, strengthening the integration of frequent, short investigative tasks could further enhance student engagement and learning outcomes. Teachers are encouraged to incorporate brief, inquiry-based activities into daily lessons to complement larger projects, thereby fostering the consistent application of scientific thinking and reinforcing critical analysis skills.

Table 3 presents the level of technology integration in science classes as perceived by the students. The indicators describe how frequently and meaningfully different technological tools such as multimedia presentations, online platforms, virtual laboratories, and educational applications are used in classroom activities. The overall mean of 3.60 (SD = 0.91) indicates that technology integration is well implemented across the different aspects measured.

Table 3. Level of Implementation of ICT Integration

Statements	Mean	SD	Interpretation
Technology is used regularly and in meaningful ways during class activities.	3.76	0.85	Well implemented
Projects require research, planning, and presentation of findings.	3.69	1.02	Well implemented
My teacher uses multimedia and online resources such as PowerPoint, Prezi and Canva to explain difficult concepts.	3.65	0.81	Well implemented
Digital tools such as Google Classroom, LMS platforms, Google Forms and Virtual Science Lab are regularly used in my science lessons.	3.49	0.89	Well implemented
I use educational apps or simulations to test hypotheses or visualize data.	3.40	0.96	Well implemented
Total	**3.60**	**0.91**	**Well implemented**

A closer examination of the results reveals that the highest mean score was obtained for the statement "Technology is used regularly and in meaningful ways during class activities" (Mean = 3.76). This indicates that students consistently experience the purposeful integration of digital tools that support their learning. Similarly, student projects demonstrate a high level of technological integration (Mean = 3.69), suggesting that digital tools are frequently utilized for research, planning, and presentation tasks. The use of multimedia resources such as PowerPoint, Prezi, and Canva (Mean = 3.65) further reflects teachers' effective use of diverse digital platforms to facilitate clearer understanding of complex scientific concepts.

In contrast, the lowest mean score, although still interpreted as well implemented, was recorded for the statement "I use educational apps or simulations to test hypotheses or visualize data" (Mean = 3.40). This finding suggests that while digital simulations and applications are present in the classroom, students may have fewer opportunities to engage in hands-on or self-directed use of these tools. Instead, technology integration appears to be more teacher-directed rather than student-centered.

Overall, the findings indicate that technology integration in the science classroom is effective, particularly in teacher-facilitated activities such as multimedia presentations and the use of digital platforms for coursework and communication. However, student-centered applications of technology—especially those involving independent inquiry through simulations and educational applications—remain an area for further enhancement. This may be influenced by factors such as limited access to devices, time constraints, or varying levels of teacher readiness in facilitating inquiry-driven digital tasks.

These results are consistent with previous studies. De Torres et al. (2023) found that interactive science simulations, such as PhET, significantly enhance students' conceptual understanding and engagement, highlighting the importance of digital experimentation in science education. Similarly, Kong (2020) emphasizes that meaningful technology integration improves learning performance, particularly when digital tools support active and inquiry-based learning. However, Kong (2020) also stresses that the effectiveness of technology integration depends not only on the availability of tools but also on pedagogical approaches and teacher preparedness, which may explain the relatively lower emphasis on student-driven use of simulations in the present study.

Taken together, the findings suggest that while the school demonstrates strong practices in technology integration, there is an opportunity to further strengthen student-led digital inquiry. Teachers are encouraged to incorporate more simulation-based activities, virtual laboratory experiences, and educational applications that enable students to test hypotheses, manipulate variables, and explore scientific concepts independently. Enhancing this aspect of instruction may further develop learners' higher order thinking skills and promote deeper engagement in scientific inquiry.

Table 4 presents the respondents' assessment of the level of implementation of Collaborative and Peer Learning in science classes. The table summarizes the mean ratings, standard deviations, and verbal interpretations of five key practices that reflect how frequently collaborative learning occurs in the classroom.

Table 4. Level of Implementation of Collaborative and Peer Learning Strategies

Statements	Mean	SD	Interpretation
Group work in science helps me understand the topic better.	4.20	0.80	Very well implemented
Group roles and responsibilities are clear during collaborative tasks.	3.93	0.81	Well implemented
I receive feedback from peers during class activities.	3.88	0.91	Well implemented
Group work is organized and helps us learn effectively.	3.86	0.88	Well implemented
We frequently work in small groups to analyze data or solve science problems.	3.71	0.82	Well implemented
Total	**3.92**	**0.84**	**Well implemented**

The results indicate that collaborative learning is well implemented, with a composite mean of 3.92, reflecting the consistent use of peer interaction, shared tasks, and cooperative learning structures. The highest-rated indicator, "Group work in science helps me understand the topic better" (Mean = 4.20), demonstrates that students perceive group work as highly effective in clarifying concepts and deepening their understanding. Other indicators including clear group roles (Mean = 3.93), peer feedback (Mean = 3.88), organized group work (Mean = 3.86), and frequent small-group activities (Mean = 3.71) also fall within the "well implemented" range. These results suggest that students regularly engage in structured collaborative activities that support their learning.

Overall, the findings indicate that the classroom environment provides substantial opportunities for cooperative learning. Students can learn from peers, develop communication skills, and collaboratively solve science-related problems. The consistency of the ratings further suggests that collaborative learning is embedded in instructional practice rather than used as an occasional strategy.

These findings are supported by existing literature. Aldossari (2022) found that well-structured collaborative learning enhances students' problem-solving abilities and conceptual understanding in science, reinforcing the high rating for group-based learning benefits observed in this study. Similarly, Garcia and Finn (2023) reported that peer feedback and shared responsibilities significantly improve student engagement and task performance, which aligns with the positive ratings for peer feedback and clearly defined group roles. However, Nguyen and McFadden (2024) caution that collaborative learning may be less effective when group activities lack structure and organization. This observation corresponds with the relatively lower mean scores for certain indicators, suggesting that further refinement in group facilitation may be beneficial.

The implications of these findings are significant for classroom practice. The strong implementation of collaborative learning indicates that teachers are successfully fostering interactive and supportive learning environments. However, the comparatively lower rating for frequent small-group activities highlights an opportunity to further expand inquiry-driven group tasks. Increasing the frequency and depth of such activities may enhance students' critical thinking, teamwork, and communication skills—competencies that are essential for success in science learning and beyond.

Table 5 presents the level of implementation of Formative Assessment and Feedback strategies as perceived by students.

Table 5. Level of Implementation of Formative Assessment and Feedback

Statements	Mean	SD	Interpretation
Teacher gives feedback that helps students improve their understanding	4.45	0.81	Very well implemented
Students get opportunities to improve their work after receiving feedback from their teachers.	4.40	0.83	Very well implemented
Students do frequent short quizzes that help them check their understanding of science lesson	4.22	0.73	Very well implemented
Assessment tasks ask the students to show their thinking, not just recall facts	4.21	0.75	Very well implemented
The feedback that the students receive help them understand their mistakes and improve their work.	4.11	0.82	Well implemented
Total	**4.28**	**0.79**	**Very well implemented**

The results indicate consistently high mean scores, with an overall mean of 4.28, interpreted as very well implemented**.** The highest-rated indicator, "Teacher gives feedback that helps students improve their understanding" (Mean = 4.45), demonstrates that feedback practices are both strong and timely. Opportunities for students to revise their work based on teacher feedback (Mean = 4.40) and the use of frequent short quizzes to monitor understanding (Mean = 4.22) also received very positive ratings. Overall, all indicators fall within the "very well implemented" or "well implemented" categories, suggesting that these assessment strategies are not only present but are deeply embedded in classroom practice.

The findings indicate that teachers consistently utilize assessment as a tool to support learning rather than merely to evaluate it. The strong emphasis on actionable feedback and opportunities for revision reflects the core principles of formative assessment. This is supported by Brookhart and Moss (2023), who highlight that high-quality feedback significantly enhances students' metacognitive awareness and academic performance, reinforcing the high rating for teacher feedback observed in this study. Similarly, Wylie and Lyon (2022) found that structured opportunities for students to revise their work promote greater ownership of learning and improved outcomes, which is consistent with the high mean scores reported.

The implications of these findings are substantial for educational practice. The strong implementation of formative assessment strategies suggests that students are provided with meaningful opportunities to reflect on their learning, address misconceptions, and improve their performance. This may contribute to deeper understanding of scientific concepts, increased academic confidence, and more sustained engagement in learning. To further strengthen these practices, schools are encouraged to sustain feedback-rich classroom environments and expand opportunities for student-led assessment, such as self-assessment and peer evaluation. Enhancing these approaches may further promote learner autonomy and reinforce continuous improvement in student learning outcomes.

Performance Level of Students in Science

Table 6 presents a comprehensive overview of the science performance levels of Grade 11 students at Llorente National High School in Eastern Samar. The distribution of grades indicates generally high levels of academic achievement in science. Notably, no students obtained scores below 74, thereby eliminating the "Did Not Meet Expectations" category and suggesting that all students demonstrate at least a baseline level of competence in science.

Table 6. Academic Performance of Grade 11 Students in Science

Grades	**Frequency**	**Percentage**	**Interpretation**
90-100	102	52.56	Outstanding
85-89	54	27.84	Very Satisfactory
80-84	28	14.43	Satisfactory
75-79	10	5.15	Fairly Satisfactory
74 below	0	0	Did not meet the expectation
Total	**194**	**100.0**	

A small proportion of students, 5.15% (n = 10), fall within the 75–79 range, classified as "Fairly Satisfactory." These students are slightly above the minimum passing level and may benefit from targeted instructional support to further improve their performance. Meanwhile, 15.2% (n = 28) achieved scores within the 80–84 range, categorized as "Satisfactory," indicating an adequate understanding of fundamental science concepts, although further development of higher-order skills may still be needed.

A larger proportion of students demonstrate stronger academic performance. Specifically, 29.9% (n = 57) obtained grades between 85 and 89, classified as "Very Satisfactory." This suggests a solid grasp of scientific concepts and the ability to apply knowledge effectively. Moreover, the majority of students, 54.3% (n = 102), achieved scores within the 90–100 range, corresponding to the "Outstanding" category. This substantial proportion reflects a high level of proficiency in science, indicating that most students are not only meeting but exceeding expected learning standards.

Overall, the findings reveal that students' performance in science is predominantly high, with the majority achieving very satisfactory to outstanding levels. This pattern suggests the presence of effective instructional practices and a supportive learning environment that fosters academic success in science. As noted by Smith

(2021), high levels of student achievement may reflect the effectiveness of educational approaches in developing scientific knowledge and skills necessary for academic excellence.

Relationship Between Innovative Science Teaching Strategies on Academic Performance of Students in Science

Table 7 presents the analysis of the relationship between science performance and various innovative science teaching strategies among Grade 11 students in Llorente National High School in Eastern Samar. The correlation coefficients and corresponding p-values provide a statistical basis to evaluate these relationships. The table summarizes the strength and significance of the relationships between several innovative science teaching strategies and student performance in science. Specifically, it reports correlation coefficients (r) between types of science teaching methods such as inquiry-based learning, problem/project-based learning, ICT (information and communication technology) integration, collaborative peer learning, and formative assessment and feedback and students' science performance, along with p-values denoting statistical significance. This analysis provides important insights into how different teaching strategies are associated with students' academic performance in science, thereby informing evidence-based instructional practices

Table 7. Correlation between Innovative Science Teaching Strategies and Science Performance

Relationship	**Correlation**	**Level of Correlation**	**P-value**	**Interpretation**
Inquiry Based Learning and Science Performance	0.01	No correlation	0.83	Not Significant
Problem and Project-Based Learning and Science Performance	0.01	No correlation	0.73	Not Significant
ICT Integration and Science Performance	0.72	Strong correlation	*0.019	Significant
Collaborative and Peer Learning Strategies and Science Performance	-0.02	No correlation	0.70	Not Significant
Formative Assessment and Feedback and Science Performance	0.68	Strong Correlation	*0.021	Significant

***significant at 0.01; *significant at 0.05*

The results indicate that two instructional strategies demonstrate strong and statistically significant positive relationships with students' science performance: ICT integration ($r = 0.72$, $p = 0.019$) and assessment practices ($r = 0.68$, $p = 0.021$). These findings suggest that increased use of technology and effective assessment approaches are associated with higher levels of academic achievement in science.

In contrast, Inquiry-Based Learning ($r = 0.01$, $p = 0.83$), Problem-/Project-Based Learning ($r = 0.01$, $p = 0.73$), and Collaborative and Peer Learning Strategies ($r = -0.02$, $p = 0.70$) exhibit negligible and non-significant correlations with science performance. These results indicate that, within the context of this study, these strategies are not significantly associated with variations in students' academic outcomes.

The findings suggest that ICT integration and effective assessment practices may provide structured support, scaffolding, and timely feedback that directly enhance students' understanding and application of scientific concepts. Such features may contribute to improved performance by facilitating clearer content delivery and more individualized learning experiences. This interpretation is consistent with the findings of Palomares Ruiz et al. (2020), who reported that ICT-mediated science instruction enhances learning outcomes by offering interactive, visual, and engaging learning environments compared to conventional approaches.

However, evidence from large-scale assessments provides a more nuanced perspective. Courtney, Karakus, Ersozlu, and colleagues (2022), drawing on data from PISA surveys, found that increased access to and use of ICT does not automatically lead to improved mathematics and science performance, particularly when technology use is unstructured or not aligned with instructional goals. This suggests that the effectiveness of ICT integration depends largely on how it is implemented within the teaching–learning process.

It is important to note that the absence of significant relationships for inquiry-based, project-based, and collaborative learning strategies does not necessarily imply that these approaches are ineffective. Rather, their impact may depend on factors such as the quality of implementation, duration of exposure, teacher expertise, and the availability of instructional resources. Additionally, as this study employs correlational analysis, the findings do not establish causal relationships between teaching strategies and student performance.

The implications of these findings are significant for educational practice. The results highlight the importance of purposeful and well-designed ICT integration and assessment practices in enhancing student achievement in science. At the same time, they underscore the need for careful and structured implementation of student-centered approaches to maximize their effectiveness. Educators and curriculum planners are therefore encouraged to adopt a balanced instructional approach that combines technological tools, robust assessment strategies, and well-facilitated active learning methods to support diverse learning needs and promote optimal academic outcomes.

Table 8 presents the results of the multiple regression analysis conducted to determine whether Inquiry-Based Learning (IBL), Problem-Based Learning (PBL), ICT Integration (ICT), Collaborative Learning (COL), and Formative Assessment and Feedback (FAF) significantly predict students' academic performance in science.

Table 7. Multiple Regression Analysis Predicting Students' Science Performance from Innovative Teaching Strategies

Predictor	**Estimate**	**β**	**t**	**p**
Intercept	0.042	0.7309	-2.43	<.001
Inquiry Based Learning	0.071	0.221	3.02	0.003
Project and Problem-Based Learning	0.066	0.052	0.88	0.381
ICT Integration	0.076	0.462	6.55	<.001
Collaborative and Peer Learning	0.059	-0.041	-0.74	0.463
Assessment Practices and Feedback	0.078	0.348	4.69	<.001

R=0.71 $R^{2=}$0.500   F(5, 188)=37.42   p=< .001   Significant

The multiple regression analysis examining the predictive effects of innovative science teaching strategies on students' science performance yielded a statistically significant overall model, $F(5, 188) = 37.42$, $p < .001$. The model explains approximately 50% of the variance in science scores ($R = .71$, $R^2 = .50$), indicating a substantial combined influence of the predictor variables on academic performance.

Among the individual predictors, Inquiry-Based Learning (IBL), ICT Integration, and Formative Assessment and Feedback emerged as significant positive predictors of science performance. Inquiry-Based Learning yielded an unstandardized coefficient of 0.214 ($\beta = 0.221$, $t = 3.02$, $p = .003$), suggesting that increased use of inquiry-based strategies is associated with improved student performance. ICT Integration demonstrated the strongest effect among all predictors (coefficient = 0.498, $\beta = 0.462$, $t = 6.55$, $p < .001$), indicating that effective use of technology substantially enhances learning outcomes in science. Similarly, Formative Assessment and Feedback significantly predicted performance (coefficient = 0.367, $\beta = 0.348$, $t = 4.69$, $p < .001$), highlighting the critical role of timely feedback and continuous monitoring of student understanding.

In contrast, Problem- and Project-Based Learning, as well as Collaborative and Peer Learning, did not significantly predict science performance in the regression model. This suggests that, within the context of this study, these strategies may not independently contribute to variations in academic achievement when other variables are considered.

It is important to address the apparent discrepancy between the correlation and regression results. While the correlation analysis indicated that Inquiry-Based Learning (IBL) was not significantly related to science performance, the regression analysis identified it as a significant predictor when analyzed alongside other variables. This difference can be attributed to the nature of multiple regression, which assesses the unique contribution of each independent variable while controlling for the influence of others.

In this case, IBL may not exhibit a strong bivariate relationship with performance; however, its contribution becomes significant within a multivariate context that includes ICT integration and formative assessment practices. This pattern may suggest the presence of suppression or interaction effects, wherein the predictive value of a variable becomes more evident when examined in combination with related factors. These findings underscore the importance of interpreting correlation and regression results complementarily rather than in isolation.

Overall, the results highlight that while individual instructional strategies vary in their direct influence, a combination of well-implemented approaches particularly ICT integration, formative assessment, and inquiry-based learning plays a significant role in enhancing students' academic performance in science.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study examined the predictive influence of innovative science teaching strategies on the academic performance of Grade 11 students, focusing on the implementation of Inquiry-Based Learning, Project-Based Learning, ICT integration, Collaborative Learning, and Formative Assessment and Feedback. Overall, the findings indicate that these strategies are generally well to very well implemented, contributing to an instructional environment that promotes active engagement, critical thinking, and continuous learning.

Inquiry-Based Learning was consistently practiced, with teachers emphasizing evidence-based reasoning and encouraging student autonomy. Project-Based Learning was also well implemented, particularly in the design of meaningful and real-world projects; however, opportunities for short, in-class investigations were less frequently observed. ICT integration demonstrated strong implementation, especially in teacher-facilitated activities and digital presentations, although student-centered use of simulations and interactive applications was comparatively less emphasized. Collaborative Learning was effectively applied through structured group work and peer interaction, supporting students' understanding of scientific concepts. Among all strategies, Formative Assessment and Feedback emerged as the most strongly implemented, with teachers providing timely, constructive feedback and regular opportunities for students to improve their work.

The distribution of students' science grades reflects a generally high level of academic performance. No student scored below 74, indicating that all learners demonstrate at least a baseline level of competence in science. A small proportion of students (5.15%) obtained scores within the 75–79 range (Fairly Satisfactory), while 15.2% achieved 80–84 (Satisfactory), reflecting adequate mastery of foundational concepts. Approximately 29.9% of students attained scores between 85 and 89 (Very Satisfactory), demonstrating strong conceptual understanding. Notably, the majority of students (54.3%) achieved scores within the 90–100 range (Outstanding), indicating that most learners exceed expected academic standards. This distribution suggests that the instructional practices employed effectively support high levels of student achievement.

Correlation analysis revealed that ICT integration ($r = 0.72$, $p = 0.019$) and assessment practices ($r = 0.68$, $p = 0.021$) have strong and statistically significant positive relationships with students' science performance. In contrast, Inquiry-Based Learning ($r = 0.01$, $p = 0.83$), Project-/Problem-Based Learning ($r = 0.01$, $p = 0.73$), and Collaborative Learning ($r = -0.02$, $p = 0.70$) showed negligible and non-significant relationships. These findings suggest that strategies providing structure, scaffolding, and timely feedback—particularly ICT integration and systematic assessment—are more directly associated with students' ability to understand and apply scientific concepts. While active learning strategies were well implemented, their effects may be less directly reflected in performance outcomes and may instead contribute to engagement and higher-order thinking skills.

The results of the multiple regression analysis further support these patterns. The overall model was statistically significant, $F(5, 188) = 37.42$, $p < .001$, explaining 50% of the variance in science performance ($R^2 = .50$). This indicates that the combined use of innovative teaching strategies is a strong predictor of student achievement. At the individual level, Inquiry-Based Learning ($\beta = 0.221$, $p = .003$), ICT integration ($\beta = 0.462$, $p < .001$), and Formative Assessment and Feedback ($\beta = 0.348$, $p < .001$) significantly and positively predicted science performance. Among these, ICT integration demonstrated the strongest effect, highlighting its critical role in enhancing learning outcomes. In contrast, Project-/Problem-Based Learning and Collaborative Learning did not significantly predict performance within the regression model, suggesting that their influence may depend on contextual or implementation-related factors.

Overall, the findings reveal that instructional strategies that integrate technology effectively, support inquiry, and incorporate structured assessment and feedback have the most substantial influence on students' academic performance in science. These results underscore the importance of prioritizing ICT integration, inquiry-based approaches, and formative assessment practices in secondary science education. By adopting a balanced and well-designed combination of these strategies, educators can create enriched learning environments that not only foster conceptual understanding and skill development but also lead to measurable improvements in student achievement.

Conclusions

1. Innovative science teaching strategies namely Inquiry-Based Learning, Project-Based Learning, ICT integration, Collaborative Learning, and Formative Assessment and Feedback play a significant role in shaping the learning environment and supporting student performance. Although certain aspects, such as student-led investigations and the use of interactive simulations, require further enhancement, these learner-centered approaches are generally well embedded and contribute to increased engagement, critical thinking, collaboration, and improved academic outcomes.

2. Grade 11 students demonstrated a high level of academic achievement in science, with no scores falling below 74 and the majority of learners performing within the Very Satisfactory to Outstanding range. This indicates that students not only understand scientific concepts but are also able to apply them effectively, reflecting the presence of supportive instructional practices and a conducive learning environment.

3. ICT integration and effective assessment and feedback practices exhibit the strongest association with students' science performance. These strategies provide structure, guidance, and timely feedback that directly support learning. In contrast, Inquiry-Based Learning, Project-Based Learning, and Collaborative Learning, while well implemented, do not demonstrate a significant direct effect on performance, suggesting that their contributions may be more indirect or dependent on implementation quality.

4. Inquiry-Based Learning, ICT integration, and Formative Assessment and Feedback are significant predictors of students' academic performance in science, with ICT integration demonstrating the strongest influence. Conversely, Project-Based Learning and Collaborative Learning did not show significant predictive effects. Overall, instructional strategies that actively engage learners, effectively utilize technology, and incorporate systematic feedback contribute most substantially to improved science learning outcomes.

Recommendations

1. Schools and teachers are encouraged to sustain and further enhance the implementation of innovative science teaching strategies, particularly formative assessment, collaborative learning, and inquiry-based instruction. Increasing opportunities for student-led investigations and hands-on digital activities

supported by adequate resources and targeted professional development can further enrich students' learning experiences.

2. Teachers should implement differentiated instructional approaches to address diverse learner needs. This includes providing targeted support for students requiring additional assistance through remediation, guided instruction, or peer-assisted learning, while also offering enrichment and advanced tasks for high-performing students to sustain academic excellence.

3. Greater emphasis should be placed on the effective integration of ICT tools and systematic assessment practices to enhance students' understanding and application of scientific concepts. The strategic combination of technology use, timely feedback, and active learning approaches is essential in maximizing student achievement and promoting deeper learning.

4. Educators should prioritize the integration of Inquiry-Based Learning, ICT, and Formative Assessment and Feedback as core instructional strategies to improve science performance. While Project-Based and Collaborative Learning remain valuable, their effectiveness may be enhanced when complemented by technology integration and robust assessment practices. Continuous professional development and access to instructional resources are essential to support effective and sustained implementation.

5. Considering that this study is limited to a single public secondary school, future researchers are encouraged to replicate the study across multiple schools with diverse contexts, including urban and rural settings, as well as institutions with varying levels of resources and technological access. Expanding the scope of the study will improve the generalizability of the findings and provide a more comprehensive understanding of how innovative science teaching strategies influence student performance in different educational environments.

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