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The relationship between laboratory skills proficiency and laboratory application skills among grade 9 students of ISPSC

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A R T I C L E I N F O

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A B S T R A C T

This study aimed to determine the laboratory skills proficiency of Grade 9 students at Ilocos Sur Polytechnic State College and examine its relationship with their academic performance in science. Using a descriptive-correlational research design, data were collected from 61 Grade 9 Laboratory High School students at the Santa Maria and Tagudin campuses using validated, reliability-tested instruments. Weighted mean and Pearson *r* correlation were used to analyze the data.

The findings revealed that students demonstrated a very high level of laboratory skills proficiency in terms of safety, manipulation, observation, measurement, and data recording and interpretation. Faculty evaluations also indicated a high level of laboratory skills application, suggesting that students were able to apply the laboratory competencies they learned in the classroom to practical scientific activities. Teachers recognized that strong laboratory proficiency enhances students' ability to perform scientific tasks effectively and supports meaningful learning experiences.

However, the Pearson *r* correlation analysis showed no significant relationship between students' laboratory skills proficiency and their laboratory application skills. Therefore, the study's hypothesis was rejected. This finding suggests that high laboratory proficiency does not necessarily translate into corresponding laboratory application, indicating that other factors may influence how students apply their scientific knowledge and skills in laboratory settings.

Based on these findings, the study recommends conducting further research using a larger sample size and incorporating additional variables that may influence laboratory performance. Such investigations may provide a more comprehensive understanding of the factors that contribute to students' laboratory competence and overall academic achievement in science.

Introduction

Science education aims to develop scientifically literate individuals who possess critical thinking, problem-solving, and decision-making skills that enable them to apply scientific knowledge to real-life situations. One of the most effective ways to achieve these goals is through laboratory-based learning, where students actively engage in experiments, observations, and scientific investigations.

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Laboratory activities provide students with opportunities to manipulate laboratory materials, observe scientific phenomena, and apply theoretical concepts learned in the classroom. Through these experiences, learners develop essential laboratory competencies such as safety practices, manipulative skills, accurate measurement, careful observation, and data recording and interpretation. These competencies, collectively known as laboratory skills, are fundamental to the development of scientific literacy (Izere, 2024).

Contemporary educational theories support the importance of laboratory learning. Kolb's Experiential Learning Theory explains that knowledge is created through the transformation of experience. In science education, laboratory activities provide concrete experiences that enable students to connect theoretical concepts with practical applications (Chengere, 2025). Likewise, Constructivist Learning Theory emphasizes that learners actively construct knowledge by interpreting experiences, reflecting on observations, and interacting with their environment. Laboratory work supports this process by allowing students to investigate, analyze, and discuss scientific concepts with their peers and teachers.

In the Philippines, the Department of Education promotes inquiry-based science education through the K to 12 Science Curriculum. The curriculum encourages students to participate in scientific investigations that foster critical thinking, problem-solving, and hands-on learning. Laboratory activities are considered an essential component of science instruction because they bridge classroom theory and practical experience. Through laboratory work, students develop scientific inquiry skills while gaining confidence in using scientific instruments and procedures (Doncillo, 2025).

Recent studies consistently highlight the positive contribution of laboratory experiences to students' learning and academic performance. Izere (2024) reported that students with strong fundamental laboratory skills generally achieved better academic performance in science subjects, suggesting that mastery of basic laboratory competencies provides a strong foundation for conceptual understanding. Similarly, Panuluh (2022) found that repeated laboratory experiments significantly improved students' science process skills, particularly in observation, experimentation, and data analysis. Saldivar (2025) likewise reported that competencies such as accurate measurement, data analysis, and interpretation significantly influenced students' academic performance in chemistry.

Beyond academic achievement, laboratory-based instruction also promotes students' motivation and engagement. Doncillo (2025) explained that hands-on laboratory activities stimulate curiosity and encourage active participation, resulting in greater interest in science learning. Likewise, Balaoro (2024) found that integrating active learning strategies into laboratory activities improved students' scientific skills, conceptual understanding, and overall academic performance by strengthening their problem-solving abilities.

Research further emphasizes that laboratory competencies—including manipulative skills, observation, measurement, safety practices, and data interpretation—are essential for meaningful scientific learning. These competencies enable students to actively participate in scientific investigations and apply classroom knowledge to authentic situations. Studies have also shown that students who regularly engage in laboratory activities tend to achieve higher academic outcomes because laboratory learning promotes inquiry, experimentation, critical thinking, and a deeper understanding of scientific concepts (Baalongbuoro & Oware, 2023).

Despite the recognized value of laboratory instruction, many schools continue to face challenges that limit the effectiveness of laboratory learning. These include inadequate laboratory facilities, insufficient equipment and materials, large class sizes, and limited opportunities for hands-on experimentation. Such conditions may hinder

the development of students' laboratory competencies and reduce their ability to apply scientific concepts effectively (Saldivar, 2025).

Although numerous studies have examined the relationship between laboratory experiences and students' academic performance, relatively few have specifically investigated how students' laboratory skills proficiency relates to their actual application of laboratory skills. Understanding this relationship is important because laboratory competence may provide the foundation for meaningful scientific learning and improved classroom performance.

Therefore, this study aims to determine the level of laboratory skills proficiency among Grade 9 students of Ilocos Sur Polytechnic State College and examine its relationship with the application of laboratory skills in Science. The findings of this study may provide valuable information for science teachers, school administrators, and curriculum developers to strengthen laboratory instruction, enhance students' practical scientific competencies, and improve the overall implementation of science education in secondary schools.

This paper is organized into eight sections: (1) Preliminary Pages, (2) Introduction, (3) Methodology, (4) Results and Discussion, (5) Conclusions, (6) Recommendations, (7) Statements and Declarations, and (8) References.

Literature review

The literature review examines existing research on laboratory skills proficiency and application among Grade 9 students.

Importance of laboratory learning in science education

Laboratory learning is widely recognized as one of the most important components of science education because it enables students to bridge theoretical knowledge with practical experience. Through laboratory activities, learners conduct experiments, observe scientific phenomena, operate laboratory equipment, and develop inquiry and investigative skills essential to scientific literacy (Doncillo, 2025).

Supporting this view, Hofstein and Lunetta emphasized that laboratory instruction plays a vital role in developing students' scientific understanding, reasoning abilities, and experimental competencies. Rather than passively receiving information through lectures, students actively construct knowledge by engaging in hands-on investigations and reflecting on their observations.

Recent studies further demonstrate the positive impact of laboratory learning on student engagement and academic achievement. Balaoro (2024) found that integrating active learning strategies into laboratory activities significantly improved students' scientific skills and overall academic performance. The study also showed that experiential learning environments promote deeper conceptual understanding of scientific principles while strengthening students' problem-solving abilities.

Similarly, Issah, Baalongbuoro, and Oware (2023) reported that biology students who regularly participated in laboratory experiments achieved higher academic performance than those who relied primarily on classroom lectures. Their findings suggest that practical laboratory experiences reinforce scientific concepts and improve students' knowledge retention.

Likewise, Chengere (2025) demonstrated that inquiry-based laboratory experiments significantly enhanced students' science process skills and critical thinking abilities. The study concluded that guided-inquiry laboratory

approaches were more effective than traditional laboratory demonstrations for promoting meaningful learning outcomes.

Consistent with these findings, the Philippine Department of Education promotes inquiry-based learning through the K to 12 Science Curriculum. The curriculum emphasizes hands-on investigation, experimentation, and scientific inquiry as essential strategies for developing students' scientific literacy, critical thinking, and problem-solving skills.

Development of laboratory skills

Laboratory skills refer to the technical and cognitive competencies required to conduct scientific investigations effectively. These skills include the ability to handle laboratory equipment properly, measure substances accurately, observe experimental changes, record data systematically, and interpret experimental findings. Collectively, these competencies enable students to perform scientific investigations accurately and apply scientific concepts in practical situations.

Recent research suggests that laboratory skills are developed through repeated exposure to hands-on learning experiences. Izere (2024) found that students who demonstrated strong fundamental laboratory skills achieved higher academic performance in science subjects. The study concluded that mastery of basic laboratory competencies serves as a foundation for deeper conceptual understanding and improved learning outcomes in science.

Similarly, Panuluh (2022) reported that students' science process skills significantly improved after participating in repeated laboratory experiments. Frequent laboratory activities enhanced learners' inquiry skills, particularly in observation, experimentation, and data analysis.

Likewise, a study conducted among Filipino science students revealed that experimental competencies, including data analysis, measurement accuracy, and interpretation skills, significantly influenced students' academic performance in chemistry courses (Saldivar, 2025). Furthermore, Doncillo (2025) explained that laboratory-based instruction promotes curiosity, active participation, and intrinsic motivation, which positively influence students' interest in science and their academic achievement. These findings suggest that laboratory activities are not merely supplementary to science instruction but are essential in developing scientific competencies and improving learning outcomes.

Components of laboratory skills

Laboratory skills comprise several interrelated competencies that enable students to conduct scientific investigations effectively. These include manipulative, observational, and measurement skills, safety practices, and data recording and interpretation skills.

Manipulative skills refer to the ability to use laboratory equipment, instruments, and materials properly and efficiently. Students are expected to develop competence in operating scientific tools such as microscopes, balances, thermometers, and graduated cylinders with precision (Bell & Bryman, 2007).
Observation skills involve carefully identifying changes, patterns, and relationships that occur during experiments. Accurate observation enables students to gather reliable evidence that supports valid scientific explanations and conclusions (Balaoro, 2024).

Measurement skills involve the accurate use of scientific measuring instruments and the correct recording of numerical values and units. Precision in measurement is essential because even minor errors may affect the accuracy and reliability of experimental results (Izere, 2024).

Safety skills are another important component of laboratory competence. Students must consistently observe laboratory safety rules and procedures to prevent accidents, protect themselves and others, and ensure the responsible handling of laboratory equipment and chemicals (Balaoro, 2024).

Finally, data recording and interpretation skills involve organizing experimental data using tables, charts, or graphs and analyzing the relationships among variables to draw meaningful scientific conclusions (Baalongbuoro & Oware, 2023).

Recent studies continue to emphasize the importance of these laboratory competencies in science education. Balaoro (2024) reported that active participation in laboratory activities enhances students' observation accuracy, procedural skills, and analytical reasoning. Likewise, studies on science process skills indicate that well-structured laboratory experiences strengthen students' abilities in data analysis, hypothesis testing, and the interpretation of experimental results. Together, these findings highlight the significant role of laboratory skills in promoting scientific inquiry, critical thinking, and academic success in science.

Laboratory skills and academic achievement

Numerous studies have examined the relationship between laboratory experiences and students' academic performance in science. The literature consistently suggests that active participation in laboratory activities enhances students' understanding of scientific concepts, strengthens inquiry skills, and improves academic achievement.

Issah et al. (2023) found that students who regularly participated in laboratory practical activities achieved significantly higher academic performance than those who had limited opportunities for hands-on experimentation. The study emphasized that laboratory experiences reinforce theoretical concepts by allowing students to apply scientific knowledge in authentic learning situations.

Similarly, Izere (2024) reported a positive relationship between students' laboratory skills and their academic achievement in chemistry. The findings indicated that students with stronger laboratory competencies were better able to apply theoretical concepts, analyze scientific problems, and perform experimental tasks effectively.

Studies conducted in the Philippine context likewise support the positive contribution of laboratory learning to students' academic outcomes. Research in the Schools Division of Iloilo found that inquiry-based laboratory instruction and well-equipped laboratory environments significantly enhanced students' academic performance in science. Likewise, another Philippine study revealed that students' experimental skills and laboratory competencies were significantly associated with their achievement in chemistry courses.

In addition to academic performance, the quality of the laboratory learning environment also influences students' attitudes toward science. Balaoro (2024) reported that adequate laboratory resources, appropriate learning conditions, and meaningful laboratory experiences positively affected students' motivation and interest in science. These findings suggest that effective laboratory instruction not only develops scientific knowledge and practical skills but also fosters positive learning attitudes that contribute to improved academic performance.

Overall, the reviewed literature demonstrates that laboratory experiences play a vital role in science education. By promoting active learning, scientific inquiry, and critical thinking, laboratory activities strengthen students' laboratory competencies and support higher levels of academic achievement in science.

Challenges in laboratory instruction

Despite the recognized importance of laboratory instruction, several challenges continue to affect its effective implementation in many schools. One of the most common concerns is the lack of adequate laboratory facilities, equipment, and instructional materials. Studies conducted in Philippine secondary schools have shown that limited laboratory resources reduce students' opportunities to participate in meaningful hands-on activities. Likewise, a study in Eastern Samar reported that the insufficient availability of laboratory equipment and materials contributed to students' low mastery of science process skills. Similarly, research involving science education students in Pagadian City found that outdated equipment and inadequate laboratory resources limited effective experimentation and negatively influenced students' scientific learning experiences (Saldivar, 2025).

Another challenge is the limited use of inquiry-based laboratory instruction. In many classrooms, laboratory activities remain focused on verification experiments that confirm concepts already discussed in lectures. While these activities reinforce theoretical knowledge, they often provide fewer opportunities for students to engage in scientific inquiry, problem-solving, and higher-order thinking. Addressing these concerns requires greater investment in laboratory facilities, continuous teacher professional development, and effective implementation of inquiry-based approaches in the science curriculum (Doncillo, 2025).

The reviewed literature consistently highlights the significant role of laboratory instruction in science education. Laboratory activities help develop essential competencies such as manipulative skills, observation, measurement, safety practices, and data recording and interpretation, all of which are fundamental to scientific inquiry. These competencies enable students to apply theoretical knowledge in practical situations while strengthening their critical thinking and problem-solving abilities. Moreover, studies consistently demonstrate that students who actively participate in laboratory activities tend to achieve better academic performance in science because laboratory-based learning promotes active engagement, inquiry, experimentation, and meaningful learning experiences (Baalongbuoro & Oware, 2023).

Although previous studies have established the importance of laboratory instruction and its contribution to students' academic achievement, limited research has examined the relationship between laboratory skills proficiency and their application among Grade 9 students in the local context. This gap underscores the need for the present study, which seeks to determine the level of laboratory skills proficiency of Grade 9 students and examine its relationship with the application of these skills in Science. The findings may provide valuable information to improve laboratory instruction, strengthen science teaching practices, and enhance students' practical scientific competencies.

Self -assessment in laboratory work

Self-assessment is an important component of laboratory learning because it encourages students to evaluate their own performance, recognize their strengths and weaknesses, and take responsibility for improving their laboratory competencies. By reflecting on their work, students become more aware of the quality of their laboratory techniques, observations, and interpretations, which contributes to the development of metacognitive and self-regulated learning skills.

Nicol and Macfarlane-Dick (2006) emphasized that self-assessment promotes self-regulated learning by encouraging students to evaluate their work against established performance standards. In laboratory settings, this process enables learners to identify errors in experimental procedures, data recording, and analysis before receiving feedback from their instructors, thereby improving both conceptual understanding and practical laboratory performance.

Research also indicates that self-assessment enhances students' technical proficiency and adherence to laboratory safety practices. Hanauer et al. (2012) found that undergraduate biology students who used self-assessment rubrics during laboratory activities demonstrated significant improvements in technical skills and compliance with laboratory safety protocols. Regular evaluation of procedures such as pipetting techniques, aseptic practices, and equipment calibration helped students become more accountable and reduced procedural errors.

Beyond improving technical competence, self-assessment promotes reflective practice in science education. Boud (1995) argued that reflective learning enables students to connect laboratory experiences with scientific concepts. Students who consistently evaluate their own laboratory performance are better able to interpret experimental results, identify sources of error, and troubleshoot unsuccessful experiments. Such reflective practices strengthen the connection between theoretical knowledge and practical application.

Despite these benefits, self-assessment also has limitations. One common concern is the accuracy of students' judgments. Kruger and Dunning (1999) explained that novice learners often overestimate their abilities because they lack sufficient metacognitive awareness to recognize their own limitations. This phenomenon, commonly known as the Dunning–Kruger effect, may reduce the reliability of self-assessment results. However, Panadero et al. (2017) reported that the accuracy of self-assessment improves significantly when students receive appropriate training, clear assessment rubrics, exemplar comparisons, and regular feedback from teachers.

In the Philippine context, studies have shown that laboratory environments, instructional strategies, and the availability of laboratory resources significantly influence students' science learning experiences. However, challenges such as inadequate laboratory facilities, insufficient equipment, and inconsistent implementation of inquiry-based instruction continue to limit students' opportunities to develop laboratory competencies effectively.

The importance of self-assessment extends beyond the educational setting into professional laboratory practice. In medical and clinical laboratories, self-assessment and self-audit procedures are widely recognized as essential quality assurance practices. The Clinical and Laboratory Standards Institute (CLSI) recommends using self-audit checklists to help laboratory personnel maintain competency, ensure compliance with established standards, and promote continuous quality improvement. These practices help minimize procedural and diagnostic errors while fostering a culture of accountability and professional excellence.

Overall, the reviewed literature suggests that self-assessment is an effective strategy for improving laboratory skills, reflective thinking, and self-regulated learning. When supported by structured assessment tools and teacher guidance, it enables students to monitor their own learning, strengthen their laboratory competencies, and become more independent learners.

Statement of the problem

This study explored the relationship between laboratory skills proficiency and the level of application skills among Grade 9 students at ISPSC. Specifically, it addressed the following questions:

1. What is the level of laboratory skills proficiency of the students in terms of:
    a. Safety skills
    b. Manipulative skills
    c. Observation and measurement skills
    d. Data recording and interpretation skills

2. What is the level of application of the laboratory skills proficiency of the Grade 9 students of Ilocos Sur Polytechnic State College?

3. Is there a significant relationship between the laboratory skills proficiency of the students and the laboratory application skills of the Grade 9 students?

Hypothesis

Laboratory learning is considered one of the most essential components of science education because it enables students to connect theoretical knowledge with practical experience**.** Chengere (2025) demonstrated that inquiry-based laboratory experiments significantly enhanced students' science process skills and critical thinking abilities. The study found that guided-inquiry laboratory approaches were more effective than traditional laboratory demonstrations at promoting student learning outcomes. Building on these findings, the current study hypothesizes that proficiency in laboratory skills is also correlated with application skills.

Scope and delimitation of the study

This study focuses on determining proficiency in laboratory skills and their application among Grade 9 Laboratory High School students at Ilocos Sur Polytechnic State College during the School Year 2025–2026. It explores laboratory skills in terms of manipulative, safety, observation, measurement, and data recording and interpretation.

Research methodology

This study employed a quantitative research approach using a descriptive-assessment and correlational research design. The study was conducted at Ilocos Sur Polytechnic State College (ISPSC), where the researcher is employed. The target population consisted of the researcher's Grade 9 Laboratory High School students enrolled in Science 9 at the Santa Maria and Tagudin campuses, both of which are satellite campuses of ISPSC.

The respondents included 61 Grade 9 students and two (2) Science teachers who evaluated the laboratory skills application of the two student groups. Data were gathered using validated and reliability-tested questionnaires. Descriptive and inferential statistics were employed to analyze the data. Specifically, the weighted mean was used to assess students' proficiency and application of laboratory skills. In contrast, the Pearson product-moment correlation coefficient (Pearson *r*) was used to determine the significant relationship between the variables under investigation.

Before data collection, the researcher secured approval from the College President through a formal letter requesting permission to conduct the study and administer the research instruments. Ethical standards were strictly observed throughout the research process. Informed consent was obtained from all respondents; participation was voluntary; and the confidentiality and anonymity of participants' responses were ensured. The questionnaires were personally administered and retrieved by the researcher.

The following ranges of values with their respective interpretation were used. The weighted mean was used to determine the level of laboratory skills proficiency:

Scale	*Statistical Range (SR)*	*Descriptive Rating (DR)*
4	*3.26-4.00*	*Very Highly Skilled (VHS)*
3	*2.51-3.25*	*Skilled (S)*
2	*1.76-2.50*	*Less Skilled (LS)*
1	*1.00-1.75*	*Not Skilled (NS)*

The weighted mean was also used to determine the level of application of the laboratory skills proficiency:

Scale	*Statistical Range (SR)*	*Descriptive Rating (DR)*
4	*3.26-4.00*	*Highly Applied (HA)*
3	*2.51-3.25*	*Applied (A)*
2	*1.76-2.50*	*Least Applied (LA)*
1	*1.00-1.75*	*Not Applied (NA*

Data presentation and analysis

Problem1.What is the level of laboratory skills proficiency of the students in terms of:

a. Safety skills;
b. Manipulative skills;
c. Observation and measurement skills;
d. Data recording and interpretation skills?

Table 1: *Level of laboratory skills proficiency as perceived by students in terms of safety skills*

Items	**Mean**	**DR**
1. I follow laboratory rules during experiments	3.37	VHS
2. I wear proper safety equipment when required	3.44	VHS
3. I handle chemicals and materials carefully	3.00	S
Composite Mean	**3.27**	**VHS**

Source: Hofstein, A.& Lunetta, V. N. (2024)
Legend: Very Highly Skilled; Skilled

Scale	Statistical Range (SR)	Descriptive Rating (DR)
4	3.26-4.00	Very Highly Skilled (VHS)
3	2.51-3.25	Skilled (S)
2	1.76-2.50	Less Skilled (LS)
1	1.00-1.75	Not Skilled (NS)

Based on the data presented, the students demonstrated a very high level of laboratory safety skills, with a composite mean of 3.27, interpreted as Very Skilled. This finding indicates that the respondents consistently practiced proper laboratory safety procedures during science activities. Among the indicators that received very high ratings were wearing appropriate personal protective equipment when required, following established laboratory rules during experiments, and handling chemicals and laboratory materials with care. These results suggest that the students have a strong awareness of laboratory safety and recognize the importance of maintaining a safe learning environment during scientific investigations.

The findings are consistent with Chengere (2025), who reported that inquiry-based laboratory activities significantly enhanced students' science process skills and critical thinking abilities. The study further revealed that guided inquiry laboratory approaches were more effective than traditional laboratory demonstrations because

they actively engaged students in scientific investigations while reinforcing proper laboratory practices. As students participate more frequently in structured laboratory activities, they become more familiar with safety protocols and develop responsible laboratory behaviors. This supports the present finding that the respondents exhibited a very high level of safety skills, reflecting the positive contribution of inquiry-based and hands-on laboratory experiences to the development of safe and effective scientific practices.

Table 2: *Level of laboratory skills proficiency as perceived by students in terms of manipulative skills*

Items	Mean	DR
1. I can properly use laboratory apparatus and tools	2.87	S
2. I can set up laboratory equipment correctly	2.76	S
3. I handle laboratory materials without damage	2.95	S
Composite Mean	**2.86**	**S**

Source: Hofstein, A., & Lunetta, V. N. (2024)
Legend: Skilled

As indicated in the table, the students' laboratory skills proficiency in manipulative skills obtained a composite mean of 2.86, interpreted as Skilled, indicating that the respondents generally demonstrated a high level of competence in performing laboratory manipulations. The individual indicators consistently received ratings within the Skilled category, with the highest-rated competencies including handling laboratory materials without causing damage, using laboratory apparatus and tools properly, and correctly setting up laboratory equipment. These findings suggest that the students have developed the practical skills necessary to perform laboratory activities effectively and responsibly.

The findings support the study of Balaoro (2024), who reported that active participation in laboratory activities enhances students' manipulative skills, experimental procedures, and analytical reasoning. Regular exposure to hands-on laboratory experiences helps students become more proficient with laboratory equipment and materials, leading to greater confidence and accuracy during scientific investigations. This agreement between the present study and the literature highlights the importance of continuous laboratory practice in developing students' manipulative competencies, which are fundamental to successful science learning.

Table 3: *Level of laboratory skills proficiency as perceived by students in terms of observation and measurement skills*

Itens	Mean	DR
1. I can accurately observe changes during experiments	2.98	S
2. I can measure substances using appropriate instruments	2.84	S
3. I record observations correctly and accurately	2.79	S
Composite Mean	**2.87**	**S**

Source: Hofstein, A., & Lunetta, V. N. (2024)
Legend: Skilled

Based on the data presented in the table, the students' laboratory skills proficiency in observation and measurement skills obtained a composite mean of 2.87, interpreted as Skilled, indicating that the respondents generally demonstrated a high level of proficiency in these competencies. The individual indicators were consistently rated in the Skilled category, with students demonstrating competence in accurately observing changes during experiments, measuring substances with appropriate laboratory instruments, and recording observations correctly

and systematically. These findings suggest that the students possess the essential observation and measurement skills needed to conduct scientific investigations accurately and reliably.

The findings are consistent with those of Issah et al. (2023), who reported that students who regularly participated in laboratory practical activities achieved significantly higher academic performance than those with limited laboratory experience. The study emphasized that hands-on laboratory activities strengthen students' ability to make accurate observations, perform precise measurements, and apply scientific concepts effectively. Regular engagement in laboratory experiments enables students to develop these fundamental skills, which are essential for generating reliable data and drawing valid scientific conclusions. The similarity between the present study and the findings of Issah et al. (2023) underscores the important role of laboratory experiences in enhancing students' observation and measurement competencies.

Table 4: *Level of laboratory skills proficiency as perceived by students in terms of data recording and interpretation skills*

Items	Mean	DR
1. I can organize data in tables or graphs	2.60	S
2. I can interpret experimental results correctly	2.63	S
3. I can draw conclusions based on laboratory data	2.66	S
Composite Mean	**2.63**	**S**

Source: Hofstein, A.& Lunetta, V. N. (2024)
Legend: Skilled

Based on the data presented in the table, the students' laboratory skills proficiency in data recording and interpretation obtained a composite mean of 2.63, interpreted as Skilled, indicating that the respondents generally demonstrated a high level of proficiency in recording, organizing, and interpreting laboratory data. All indicators were consistently rated in the Skilled category, suggesting that students were able to organize experimental data systematically and analyze relationships among variables during laboratory activities.

Among the indicators, the ability to conclude laboratory data obtained the highest mean (2.66), followed by the ability to interpret experimental results correctly (2.63) and the ability to organize data using tables and graphs (2.60). These findings indicate that the students possess the fundamental competencies needed to process experimental data and use scientific evidence to support logical conclusions.

The findings are consistent with Doncillo's (2025) study, which reported that laboratory-based instruction promotes students' curiosity, active participation, and intrinsic motivation to learn science. The study emphasized that meaningful laboratory experiences encourage students to engage actively in scientific investigations, thereby strengthening their ability to accurately record observations, organize experimental data, interpret results, and draw evidence-based conclusions. The agreement between the present study and the literature suggests that regular participation in laboratory activities contributes not only to students' motivation but also to the development of essential data recording and interpretation skills that support scientific inquiry and academic success.

Table 5: *Summary of laboratory skills proficiency as perceived by students*

Items	Mean	DR
1. Safety skills	3.27	VHS
2. Manipulative skills	2.86	S
3. Observation and measurement skills	2.83	S

4.	Data recording and interpretation skills	2.63	S
Composite Mean		2.90	S

Source: Hofstein, A., & Lunetta, V. N. (2024)
Legend: Very Highly Skilled; Skilled

The summary table shows that the overall laboratory skills proficiency, as perceived by the students, obtained a composite mean of 2.90, interpreted as Skilled. This finding indicates that the respondents generally demonstrated a high level of proficiency across all dimensions of laboratory skills. Although slight variations were observed across skill areas, the overall results suggest that the students possess the essential competencies to perform laboratory activities effectively and responsibly.

These findings reinforce the view that laboratory activities are not merely supplementary components of science instruction but are fundamental in developing students' scientific knowledge, practical competencies, and inquiry skills. Regular participation in laboratory experiences provides students with opportunities to strengthen their manipulative, observational, measurement, safety, and data-interpretation skills, all of which are necessary for meaningful scientific learning.

The present findings are consistent with Balaoro (2024), who reported that integrating active learning strategies into laboratory activities significantly improved students' scientific skills and academic achievement. The study emphasized that experiential and hands-on learning environments enhance students' understanding of scientific concepts while developing the practical competencies required for laboratory work. Collectively, these findings underscore the importance of continuously strengthening students' laboratory skills through well-designed laboratory activities and inquiry-based instruction further to enhance both laboratory competence and science learning outcomes.

2. What is the level of application of the laboratory skills proficiency of the Grade 9 students of Ilocos Sur Polytechnic State College in terms of:

a. Safety skills;
b. Manipulative skills;
c. Observation and measurement skills;
d. Data recording and interpretation skills?

Table 6: *Level of application of laboratory skills as evaluated by the faculty in terms of safety skills*

Items	**Mean**	**DR**
1. Follows laboratory rules during experiments	3.71	HA
2. Wears proper safety equipment when required	3.74	HA
3. Handles chemicals and apparatus carefully	3.55	HA
Composite Mean	**3.67**	**HA**

Source: Anderson & Krathwohl (2021)
Legend: Highly Applied

Scale	Statistical Range (SR)	Descriptive Rating (DR)
4	3.26-4.00	Highly Applied (HA)
3	2.51-3.25	Applied (A)
2	1.76-2.50	Least Applied (LA)
1	1.00-1.75	Not Applied (NA

The data presented in the table reveal that the level of application of laboratory skills, as evaluated by the faculty on safety skills, is at the composite mean (3.67), interpreted as Highly Applied, in laboratory skills proficiency. When considering the individual items, all indicators fall in the same high applied rating. Students report that they wear proper safety equipment when required, follow laboratory rules during experiments, and handle chemicals and apparatus carefully. These findings align with Nicol and Macfarlane Dick (2006), who emphasized that self-assessment fosters self-regulated learning by making students judge the quality of their own work against standards in science labs. This means students can identify errors in technique, data recording, or analysis before instructor feedback, leading to improved conceptual understanding.

Table 7: *Level of application of laboratory skills as evaluated by faculty in terms of manipulative skills*

Items	Mean	DR
1. Uses laboratory apparatus and tools	3.65	HA
2. Sets up laboratory apparatus correctly	3.58	HA
3. Handles laboratory materials with control and precision	3.60	HA
Composite Mean	**3.61**	**HA**

Source: Anderson & Krathwohl (2021)
Legend: Highly Applied

Based on the data presented in the table, the application of laboratory skills, particularly manipulative skills, as evaluated by the faculty, obtained a composite mean of 3.61, interpreted as Highly Applied. This indicates that the students consistently demonstrated a very high level of application of manipulative skills during laboratory activities. All indicators were rated in the Highly Applied category, indicating that students were able to use laboratory apparatus and tools properly, handle laboratory materials with control and precision, and correctly set up laboratory equipment before conducting experiments. These findings suggest that the students are capable of applying their laboratory knowledge and practical skills effectively in actual laboratory settings.

The findings are consistent with Doncillo's (2025) study, which reported that laboratory-based learning promotes curiosity, active participation, and meaningful engagement in science. Through regular hands-on laboratory experiences, students develop greater confidence and competence in performing laboratory procedures, enabling them to apply manipulative skills accurately and efficiently. The agreement between the present study and the literature reinforces the view that laboratory activities are not merely supplementary to classroom instruction but are essential for developing students' practical scientific competencies and preparing them for more effective scientific investigations.

Table 8: *Level of application of laboratory skills as evaluated by faculty in terms of observation and measurement skills*

Items	Mean	DR
1. Makes accurate observations during experiments	3.63	HA
2. Measures substances using appropriate instruments	3.65	HA
3. Records measurements correctly and accurately	3.56	HA
Composite Mean	**3.61**	**HA**

Source: Anderson & Krathwohl (2021)
Legend: Highly Applied

Based on the data presented in the table, the application of laboratory skills in observation and measurement, as evaluated by the faculty, obtained a composite mean of 3.61, interpreted as Highly Applied. This indicates that the students consistently demonstrated a very high level of application of observation and measurement skills during laboratory activities. All indicators were rated in the Highly Applied category, indicating that students were able to measure substances using appropriate laboratory instruments, make accurate observations during experiments, and record measurements correctly and systematically. These findings suggest that the students can effectively apply these essential laboratory skills in conducting scientific investigations.

The findings are consistent with the study of Issah et al. (2023), who reported that students who regularly participated in laboratory practical activities demonstrated significantly higher academic performance than those with limited laboratory experience. Their study emphasized that repeated hands-on laboratory activities strengthen students' observation and measurement skills by providing opportunities to apply scientific concepts through experimentation. Likewise, regular laboratory engagement helps students develop accuracy in making observations, using measuring instruments correctly, and recording experimental data, which are essential competencies for producing reliable scientific results.

These findings further suggest that continuous exposure to laboratory activities enables students to apply observation and measurement skills with confidence and precision, thereby supporting meaningful scientific inquiry and improving laboratory performance.

Table 9: *Level of application of laboratory skills as evaluated by faculty in terms of data recording and interpretation skills*

Items	**Mean**	**DR**
1. Organizes data in tables or graphs clearly	3.52	HA
2. Interprets experimental results correctly	3.56	HA
3. Draws valid conclusions based on laboratory data	3.47	HA
Composite Mean	**3.52**	**HA**

Source: Anderson & Krathwohl (2021)
Legend: Highly Applied

Based on the data presented in the table, the application of laboratory skills in terms of data recording and interpretation, as evaluated by the faculty, obtained a composite mean of 3.52, interpreted as Highly Applied. This indicates that the students consistently demonstrated a very high level of application of data recording and interpretation skills during laboratory activities. All indicators were rated in the Highly Applied category, indicating that students were able to interpret experimental results correctly, clearly organize data using tables or graphs, and draw valid conclusions based on laboratory findings. These results suggest that the students can effectively analyze and communicate scientific data, which are essential competencies in conducting meaningful scientific investigations.

The findings are consistent with the work of Boud (1995), who emphasized that reflection and self-assessment are central to the development of reflective practitioners. According to Boud, students who regularly evaluate their own laboratory performance become better at connecting experimental results to theoretical concepts, identifying errors, and improving subsequent laboratory work. This reflective process strengthens students' ability to interpret findings critically and draw evidence-based conclusions, effectively bridging the gap between practical laboratory experience and conceptual understanding.

These findings suggest that students' strong application of data recording and interpretation skills reflects not only their technical competence but also their ability to think critically about experimental evidence. Such competencies are essential for developing scientific reasoning and promoting meaningful learning in science.

Table 10: *Summary of laboratory application skills proficiency as perceived by faculty*

Items	**Mean**	**DR**
1. Safety skills	3.67	HA
2. Manipulative skills	3.61	HA
3. Observation and measurement skills	3.61	HA
4. Data recording and interpretation skills	3.52	HA
Composite Mean	**3.60**	**HA**

Source: Anderson & Krathwohl (2021)
Legend: Highly Applied

The summary table shows that the overall **application of laboratory skills**, as evaluated by the faculty, obtained a composite mean of **3.60**, interpreted as **Highly Applied**. This finding indicates that the students consistently demonstrated a very high level of application across all dimensions of laboratory skills. From the teachers' perspective, the students effectively applied the laboratory competencies learned in the classroom to laboratory activities. This suggests that classroom instruction successfully translates into practical scientific competence, thereby enhancing students' preparedness for scientific investigations and contributing to the overall quality of science education.

The findings are consistent with Doncillo's (2025) study, which reported that laboratory-based learning promotes curiosity, active participation, and meaningful engagement in science. The study explained that regular involvement in hands-on laboratory activities strengthens students' practical skills while enhancing their academic achievement and interest in science. Likewise, the present findings reinforce the view that laboratory activities are not merely supplementary components of science instruction but are essential for developing students' scientific competencies, improving laboratory performance, and fostering meaningful learning experiences. These results underscore the importance of providing students with ongoing opportunities to participate in well-designed laboratory activities that foster both scientific knowledge and practical competence.

3. Is there a significant relationship between the laboratory skills proficiency of the students and the laboratory application skills?

Table 11: *Correlation between laboratory skills proficiency of the students and the laboratory application skills*

Laboratory skill application	Pearson Correlation	Relationship	P-value	Interpretation	Decision H_0
Safety skills proficiency and application	.208	Low correlation	.106	Not Significant	Supported
manipulative skills and application	-.084	Negligible correlation	.517	Not Significant	Supported
observation and measurement skills	-.012	Negligible correlation	.110	Not Significant	Supported
data and interpretation skill	.076	Negligible correlation	.559	Not Significant	Supported

laboratory skill and application as a whole	.030	Negligible correlation	.814	Not Significant	Supported

The analysis of the relationship between students' laboratory skills proficiency and laboratory application skills reveals no statistically significant relationship across all measured indicators**.** Specifically**,** safety skills proficiency exhibited a low positive correlation (r = 0.208), but this relationship was not statistically significant (p = 0.106). This indicates that although there is a slight tendency for students with higher safety skills proficiency to demonstrate better laboratory application, the association is weak and may reflect chance. Similarly, manipulative skills showed a negligible negative correlation (r = -0.084, p = 0.517), suggesting that proficiency in handling laboratory tools and equipment does not translate into improved laboratory application. In fact, the negative direction, although trivial, implies no meaningful linear relationship. For observational and measurement skills, the correlation was also negligible (r = -0.012, p = 0.110), indicating that students' ability to observe and measure accurately does not significantly influence their ability to apply laboratory procedures. In the case of data and interpretation skills, a negligible positive correlation was found (r = 0.076, p = 0.559), further reinforcing the absence of a meaningful relationship between analytical skills and actual laboratory application. When considered as a whole, laboratory skills proficiency demonstrated a negligible correlation with laboratory application (r = 0.030, p = 0.814), indicating no significant linear association between the two variables. Given that all p-values are greater than the 0.05 level of significance, the null hypothesis is supported in all cases, indicating that laboratory skills proficiency does not significantly associate with laboratory application among the students.

Discussion

The findings indicate that students generally perceived themselves as skilled in all dimensions of laboratory skills proficiency, including safety, manipulative, observation and measurement, and data recording and interpretation. This suggests that they possess the fundamental competencies needed to conduct laboratory activities effectively and connect theoretical knowledge with practical experience. Specifically, students demonstrated very high proficiency in safety skills, reflecting their awareness of laboratory protocols and responsible handling of equipment and chemicals. This finding is consistent with Chengere (2025), who reported that inquiry-based laboratory activities enhance students' science process skills, critical thinking, and laboratory competence.

Students also exhibited satisfactory proficiency in manipulative skills, indicating their ability to handle laboratory equipment and materials appropriately. This supports Balaoro (2024), who found that active laboratory engagement improves students' experimental procedures, observational accuracy, and analytical reasoning. Likewise, satisfactory ratings in observation and measurement skills suggest that students can accurately observe experimental changes, use measuring instruments correctly, and obtain reliable data. These findings agree with Issah et al. (2023), who reported that laboratory practical activities improve students' academic performance, and with Panuluh (2022), who emphasized that repeated laboratory experiences strengthen observation, experimentation, and data analysis skills.

Similarly, students demonstrated satisfactory proficiency in data recording and interpretation, particularly in organizing data, interpreting results, and drawing conclusions from laboratory findings. This supports Doncillo (2025), who explained that laboratory-based learning promotes curiosity, active participation, and intrinsic motivation, thereby enhancing students' scientific competencies and academic achievement. Overall, the findings reinforce the view that laboratory activities are essential components of science instruction rather than merely supplementary learning experiences. They also affirm Balaoro's (2024) conclusion that active learning strategies integrated into laboratory work improve students' scientific skills and academic performance.

Faculty evaluations likewise revealed that students demonstrated highly applied laboratory skills across all domains. In safety skills, teachers observed consistent adherence to laboratory protocols, supporting Nicol and Macfarlane-Dick's (2006) view that self-assessment promotes self-regulated learning by helping students recognize and correct procedural errors. Similarly, Hofstein and Lunetta (2004) emphasized that laboratory instruction develops scientific understanding, reasoning, and experimental competence.

Students also demonstrated highly applied manipulative skills, suggesting that they could effectively translate theoretical knowledge into practical laboratory performance. These findings support Doncillo (2025), who highlighted the role of laboratory learning in promoting curiosity and active engagement, and Issah, Baalongbuoro, and Oware (2023), who found that regular laboratory participation strengthens conceptual understanding and knowledge retention.

Faculty likewise rated students highly in observation and measurement skills, indicating competence in making accurate observations and measurements during experiments. These findings are consistent with Balaoro (2024), who emphasized that laboratory engagement enhances observation accuracy and analytical reasoning. Although Dunning and Kruger (1999) noted that novice learners may overestimate their abilities because of limited metacognitive awareness, Panadero et al. (2017) demonstrated that structured self-assessment with clear rubrics and feedback significantly improves the accuracy of students' self-evaluations.

In terms of data recording and interpretation, students were also rated highly, demonstrating competence in organizing, analyzing, and interpreting laboratory data. These findings are consistent with Hanauer et al. (2012), who found that self-assessment improves technical proficiency and procedural accuracy, and with Boud (1995), who emphasized that reflective practice enables students to connect experimental results with theoretical concepts and improve future performance. Likewise, the findings agree with Baalongbuoro and Oware (2023), who highlighted the importance of data analysis and interpretation in developing scientific literacy.

Overall, faculty evaluations indicate that students consistently apply their laboratory skills during scientific investigations. These findings suggest that effective laboratory instruction enhances students' practical competence, scientific reasoning, and readiness for more advanced science learning. The results support Doncillo (2025), who emphasized that laboratory learning promotes curiosity, active participation, and academic achievement, while reinforcing the importance of continuously strengthening laboratory instruction to sustain students' scientific competencies.

Although students demonstrated satisfactory proficiency in laboratory skills and highly applied laboratory skills, the correlation analysis revealed no significant relationship between laboratory skills proficiency and laboratory application. This indicates that proficiency alone does not necessarily translate into actual laboratory application and that other factors may influence students' performance in laboratory settings. Nevertheless, the findings remain consistent with Doncillo (2025), who emphasized the value of laboratory learning in promoting scientific competence, and they highlight the continuing need to strengthen students' laboratory experiences through meaningful, inquiry-based instruction.

Theoretical contributions

The findings suggest that although students demonstrate proficiency in laboratory procedures, they may have difficulty independently applying these skills to solve unfamiliar scientific problems. This indicates that procedural knowledge alone does not necessarily translate into meaningful application. The results support Kolb's Experiential Learning Theory, which posits that effective learning occurs through a cycle of concrete experience,

reflective observation, abstract conceptualization, and active experimentation. While students gain hands-on experience in the laboratory, they may require more opportunities for reflection and conceptual understanding to transfer their learning to new situations effectively.

The findings also support Constructivist Theory (Piaget & Vygotsky), which emphasizes that learners actively construct knowledge through meaningful experiences and social interaction. Laboratory activities are essential learning experiences that enable students to connect theory with practice and develop a deeper scientific understanding. Furthermore, the results are consistent with Cognitive Load Theory, which suggests that students who focus primarily on mastering procedural steps may have limited cognitive resources available for higher-order thinking and problem-solving. Consequently, science instruction should move beyond procedural mastery by incorporating inquiry-based and reflective laboratory activities that promote critical thinking, conceptual understanding, and the meaningful application of laboratory skills.

Conclusions

The study examined the relationship between proficiency in laboratory skills and laboratory application skills among Grade 9 students. The findings revealed that students perceived themselves as demonstrating a very high level of proficiency in laboratory skills, including safety, manipulative skills, observation and measurement, and data recording and interpretation. These competencies are fundamental to science education because they enable learners to connect theoretical knowledge with practical experience through experimentation, observation, and scientific inquiry.

Similarly, faculty evaluations indicated a high level of laboratory skills application, suggesting that students are generally able to apply their laboratory competencies during science activities. From the teachers' perspective, students' strong laboratory application reflects the effectiveness of classroom instruction in developing practical scientific skills and promoting safe, meaningful laboratory experiences.

However, the Pearson *r* correlation analysis revealed no significant relationship between laboratory skills proficiency and laboratory application skills. This finding suggests that although students possess high levels of laboratory proficiency and demonstrate strong laboratory application, proficiency alone does not necessarily predict how effectively these skills are applied in laboratory settings. Other factors may influence students' ability to transfer laboratory knowledge into practice.

This study acknowledges its limitations, including the relatively small sample of Grade 9 students at Ilocos Sur Polytechnic State College and the use of a limited set of predictor variables. Future studies are encouraged to include a larger, more diverse sample and to examine additional factors that may influence laboratory application skills. Such investigations may provide a more comprehensive understanding of the relationship between laboratory skills proficiency, laboratory application, and students' learning outcomes in science.

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