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Pedagogical Skills Through Laboratory-Based Instruction and Its Relations to the Current Status of the Science Laboratory Facilities

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Abstract

This study investigated the relationship between the condition of science laboratory facilities and the pedagogical practices of Senior High School science educators in public secondary schools within the Balicuatro Area, Division of Northern Samar. It specifically examined how the availability, utilization, and safety of laboratory resources relate to instructional strategies, classroom management, and laboratory-based teaching methods. Employing a descriptive-correlational research design, the study involved 67 respondents composed of science teachers and school heads. A validated questionnaire served as the primary data-gathering instrument, and data were analyzed using descriptive statistics—including mean and percentage—and inferential statistics such as Pearson correlation. Findings revealed that while classroom management was rated satisfactorily, the use of interactive strategies and laboratory-focused teaching methods remained limited. Laboratory facilities were generally assessed as moderately adequate, though inconsistencies in usage and safety protocol implementation were evident. Among the variables studied, only the adequacy of laboratory facilities showed a statistically significant correlation with teachers' pedagogical practices ($r = 0.265$, $p = 0.030$), suggesting that better-equipped laboratories may support more effective teaching. However, no significant relationship was found between pedagogical skills and laboratory usage ($p = 0.523$) or adherence to safety standards ($p = 0.989$). These findings imply that the presence of adequate laboratory infrastructure alone does not guarantee improved instructional practices unless accompanied by proper utilization and adherence to safety measures. Based on these insights, the study proposes a strategic action plan to enhance both laboratory infrastructure and teacher capability. The results underscore the need for integrated policies that address physical resources and pedagogical development to improve science education in rural and underserved contexts. relationship emerged between pedagogical skill and the levels of laboratory use ($p = 0.523$) or safety adherence ($p = 0.989$). These results suggest that improving the physical quality of laboratory facilities can help enhance science instruction, but access alone may not guarantee effective practice unless supported by consistent use and safety protocols. To address these gaps, a strategic action plan was proposed, aimed at both upgrading laboratory infrastructure and strengthening teacher capability through targeted support. The study provides valuable insights for school leaders and policymakers

working to improve the quality of science education in underserved regions.

Keywords: *Science laboratory, pedagogical practices, instructional strategies, classroom management, Northern Samar*

Introduction

- Background and rationale

Science academic formation at the secondary level is one of the important aspects of academic formation globally. It plays a vital role in students' preparation for their tertiary education and future career paths. These subject nurtures critical thinking skills, problem-solving abilities and scientific literacy, abilities that are vital in the developing world. Countries around the globe greatly invest in well-equipped laboratories, recognizing their role in inquiry-based learning and scientific innovations. It is seen in countries like Finland, Singapore, and South Korea that science laboratories are not merely a supplementary facility but rather a foundation for pedagogy that allows every student to explore, discover and learn.

In the context of the Philippines, the quality of science education continues to be a great concern. According to OECD (2022), during the Programme for International Student Assessment 2022, the Philippines ranked third to last in science with an average score of 356. This alarming result, which echoed around the country, led the Department of Education to be questioned for its capacity in the academic formation of Filipino students nationwide.

Science education quality in Senior High Schools remains a remarkable concern in the Philippines, specifically in rural areas such as the coastal and island municipalities of Balicuatro Area, Division of Northern Samar. One of the most important factors seen in this area is the availability of standard laboratory facilities that pose a threat to the declining scientific literacy among its students and the mastery of laboratory-based pedagogical skills with the teachers and school heads. It is sad to say that this issue continues to emerge, hindering the efficient and effective delivery of science education in the said rural area.

The result of the 2024 National Achievement Test for Grade 12 Senior High School shows concern about science proficiency. While there is no particular ranking for the Northern Samar Division, the performance of the students was far behind the national standard average, especially when it comes to science subjects. This poor performance in science can be attributed to the present situation of public senior high schools in Balicuatro Area, Northern Samar Division, due to the inadequate laboratory-based facilities, equipment, and pedagogical skills in laboratory-based instruction of science teachers.

The public Senior High School in the Balacuatro Area, Northern Samar Division, continues to encounter inadequacy in the laboratory facilities and equipment. The absence of this scientific infrastructure and equipment continues to limit both the teachers and students from engaging completely in hands-on scientific experiments and inquiry-based learning.

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The research gap of this study evolves around the concept that there is a lot of research on the availability and efficacy of science laboratory facilities in urban settings, while in rural areas, it remains scarce. These further contributed to a wide-scale educational gap with the students in geographically isolated areas and their deprivation of necessary laboratory resources, a critical tool for hands-on learning. The inadequate laboratory facilities in the Balicuatro Area, Division of Northern Samar, hinder teachers' ability to fully engage students in different scientific tasks that verify theoretical concepts.

The lack of science laboratory facilities in rural areas affects the delivery of quality science education to students. Further, it hampers students' development in the importance of exploratory learning, analytical thinking and problem-solving abilities. The SHS-science teachers and heads of schools in the Balicuatro Area endure outdated, underfunded and lacking facilities to solely rely on theoretical instructions in the delivery of scientific competencies to the students.

This study aims to identify the pedagogical skills through laboratory-based instruction and its relation to the current status of the science laboratory facilities in Balicuatro Area, Division of Northern Samar. Through the assessment of the current status of laboratory facilities and its impact on the pedagogical skills of Senior High School science teachers and school heads, this study aimed to give valuable insights into the challenges faced by public rural schools and introduce an action plan to enhance science education in Balicuatro Area, Northern Samar Division.

- Review of related literature

A review of related literature was presented in this chapter to further provide theoretical perspectives and diverse insights and outlined from various applicable scholarly sources, research periodicals, and research studies. These sources, written by established authorities in the field, have explored the crucial role of science laboratory infrastructure in enhancing the quality of science education, with a specific focus on pedagogical skills, student learning outcomes, and the challenges faced by schools in rural areas like the province of Northern Samar.

This part also illustrates the synthesis of the relevant literature, summarizing key findings, highlighting gaps in existing research and correlating it with this study. The detailed analysis of the different existing bodies of work points out important challenges that emerge during teacher preparation, laboratory maintenance, and student participation, which must be addressed in this study. The review ultimately aimed to give a comprehensive knowledge of how science laboratory facilities, combined with effective pedagogical practices, can foster better learning experiences and outcomes for students in the Balicuatro Area, Division of Northern Samar, thereby bridging the gaps in science education in this region.

Pedagogical Skills and Science Education in Relation to Laboratory Usage

The science laboratory infrastructures are essential for effectual science education; their impact largely depends on the pedagogical skills of teachers on scientific theories and hands-on learning. Experienced SHS science teachers and heads of schools are important to intensify the advantage of using laboratory facilities and establishing knowledge in conducting experiments. According to Goldstein et al. (2021), the effectiveness of science laboratory work is highly dependent on the teacher's mastery in guiding students in critical thinking and scientific inquiry. Gikandi & Morrow (2022) justify that teachers who are proficient in pedagogical strategies can better promote student understanding and curiosity during laboratory-based learning.

One of the significant teaching strategies in science laboratory-based instruction is inquiry-based learning (IBL). According to Clark et al. (2021), in this method, students articulate questions, do experiments, and analyze results to come up with their understanding of scientific theories. In the Balicuatro Area, Division of Northern Samar, the same method is used, but during the experimental phase, implementation is hampered due to the lack of resources, preventing the proper completion of the IBL strategies. Dewey (2020) points out that inquiry-based learning conforms with the principles of constructivist teaching, which emphasize the active formulation of knowledge rather than passive reception.

Furthermore, Problem-Based Learning (IBL), together with Project-Based Learning (PBL), is renowned as an efficient pedagogical approach in science. Thomas (2021) added that during Problem-Based Learning (PBL), learners are given real-world scientific problems that make them apply scientific concepts or theories to arrive at a solution. This method is very important in the development of critical thinking and collaborative skills for students most likely to work in a team to solve intricate problems. According to Tomas (2020), PBL helps students pursue self-directed learning, thus motivating and committing them to scientific inquiry.

Barandford et al. (2020) state that the different strategies in pedagogical skills, when aligned to laboratory experiences, facilitate advanced cognitive skills like analysis, evaluation and synthesis. Gijbels et al. (2019) conducted a study indicates that learners in PBL and PjBL settings are often engage to critical reflection on their learning activity, which is important in the creation of profound understanding in scientific principles.

Additionally, Savery (2020) emphasizes that the combination of IBL, PBL and PjBL leads to increased collaboration among students that determines the value of teamwork and communication skills. When students work together to design experiments, collect data, and interpret results during laboratory activities, they are most likely to achieve the objectives. According to Pugh and Shapiro (2021), these collaborative skills are not only critical for success in the scientific field but also recognized in STEM career paths.

In connection with teacher preparation during science laboratory activities, Macdonald et al. (2021) state that teachers who are trained in active learning strategies are more successful in establishing student engagement during this scientific task. In addition, Tsai (2021) asserts that the skill of creating a classroom environment that boosts inquiry, collaboration and critical thinking is important to maximize the use of laboratory facilities.

Finally, the integration of technology in laboratory teaching strategies leads to improved learning experiences. Krajcik and Blumenfeld (2020) describe those digital tools, simulations, and virtual lab support students in conducting well-engaged scientific experiments even if laboratory resources are scarce. The situation in Balicuatro Area, Division of Northern Samar, is far behind with these modern strategies because of the absence of technological advancement in the area, leaving the students confined to conventional ways of learning scientific theories. In contrast, Wilson (2020) and Bakia et al. (2021) explain that technological innovations offer additional opportunities for inquiry-based learning and project-based learning, giving students a chance to have other ways of exploring scientific concepts.

Science Laboratory Facilities and Their Role in Science Education

Science laboratory facilities are the intrinsic element in connecting theoretical knowledge to practical application, promoting deeper student engagement and comprehension of scientific concepts. In the study of Gracia and Lee (2023) on the influence of laboratory infrastructure and academic outcomes, they found that fully equipped science laboratory facilities give students the opportunity to have a fully engaged experience with scientific scenarios, allowing them to grasp scientific theories through visualization and experimentation. Garcia and Lee (2023) claimed that laboratory facilities enhance abstract formulation, critical thinking, and problem-solving capabilities.

The comparison of the effectiveness of laboratory-based instruction and traditional lecture-based learning by Freeman et al. (2023) revealed that laboratory-active students with hands-on experience in the different laboratory tasks performed better than those who were confined to textbook-based learning. Laboratory-based instruction promotes a collaborative educational experience. Through the laboratory task, students visualize complex theories and are able to use them in practical applications. The study also revealed that laboratory instruction not only helps in the improvement of retaining knowledge but also enhances cognitive skills in science practice.

The development of Higher-order thinking skills through regular laboratory engagement improves critical and analytical thinking skills, as claimed by Smith and Jones (2023). Their research stated that laboratory-based learning is important in enhancing students' cognitive abilities, which are fundamental to the success of both STEM and non-STEM disciplines. Johnson and Wells (2023) revealed that students who engage in laboratory activities show better communication and teamwork skills. Pederson and Liu (2023) concurred with this result by asserting that laboratory-based instruction creates an environment where interpersonal communication is important to students and, therefore, improves their ability to articulate ideas and engage effectively.

The National Research Council (2023) investigated the critical contribution of laboratory resources in developing student interest and motivation in the scientific field. The result of their study illustrates that students who are placed in well-equipped science laboratories show a stronger interest in science and are more likely to pursue STEM careers field. Further, the council states that the possibility of engaging in scientific concepts in practical scenarios helps students value the importance of science in their daily lives. The result of the study demonstrated the important influence of laboratory infrastructure in nurturing not only the academic aspect but also the career aspiration in science and technology.

In the same context, Osborne et al. (2023) highlight the need for laboratory-based instruction to enhance students' eagerness for scientific subjects. The result of their study supported the findings of the National Research Council (2023), which states that students who are engaged in laboratory activities are more likely to chase STEM careers. Their study further indicates that hands-on learning settings promote a deep recognition of the importance of science in directing real-world problems, thus encouraging students to gauge the practical applications of their studies.

Keller et al. (2023) and Park & Lee (2023) investigated the role of laboratory facilities in developing creativity and innovation among students. The result demonstrated that laboratory settings advocate critical and creative thinking; these come to realization when students are provided with the opportunities to use scientific concepts in solving complex real-life problems. Keller et al. (2023) perceived that students who were active in laboratory experiments were more likely to create innovative solutions and participate in creative problem-solving. Park and Lee (2023) delved deeper into this relationship, highlighting that laboratory work engages students in critical thinking and using their knowledge in unique ways. The study showed that experience in a laboratory environment is necessary for the development of the innovative mindset of the students, which is significant in scientific inquiries and technological advancements in different industries.

The study of Parker and Williams (2023) focused on how laboratory-based instruction supports intrinsic motivation in laboratory-based instruction. The result of the study revealed that when students are active in hands-on scientific experiments, they have this sense of greater achievement, which develops their motivations and moves forward with scientific studies. Further, they argued that laboratory activities give students various opportunities to directly use theoretical knowledge in real-world problems, increasing their sense of ownership with their learning. The study asserted that Laboratory-based learning has an important role in creating students' intrinsic motivation, which is the most important aspect of academic success in science education.

Impact of Science Laboratories on Student Learning Outcomes

Many studies have attributed the significance of laboratory infrastructure to students' academic performance, most specifically in fostering cognitive and non-cognitive skills. The study made by Smith and Jone (2020) indicated that students who actively participated in laboratory experiments manifested superior problem-solving abilities and better academic performance than those who purely relied on the textbook learning method. This study discovered that laboratory activities give students a chance to test hypotheses, observe outcomes, and conclude, which helps them gain a deeper comprehension of scientific principles. Their study conveyed that learners in laboratory-based environments were more capable of handling more complex scientific concepts.

Krajcik and Blumenfeld (2020) revealed that a comprehensive understanding of science concepts is a byproduct of a fully equipped laboratory facility and students' participation in hypotheses formulation, experimentation, and data analysis. Their research showed that inquiry-based learning paves the way for the student to synthesize knowledge from different disciplines, creating relationships with various scientific concepts and promoting them to understand science as an interconnected body of knowledge.

O'Donnell et al. (2021) and King & Howard (2022) reinforced the importance of laboratory experience in long-term knowledge retention and enhancement of scientific skills. The long retention of scientific knowledge over some time was revealed by those students who are engaged in laboratory-based activities, as revealed by O'Donnell et al. (2021). The study of King and Howard (2022) illustrated that laboratory experimentation improves knowledge retention while concurrently nurturing important scientific competencies comprising the collection of data, analysis, and interpretation that are deemed to be important for the advancement of different science-related fields.

The reality is that not all of the schools around the world enjoy the benefits of laboratory-based learning due to different limiting factors. IJRISS (2023) uncovered that students coming from well-equipped schools do tend to have chances to engage in hands-on learning, while those schools with limited resources are most likely to face difficulties such as under-modernized laboratory equipment and minimal laboratory exposure. Schools that do not have access to updated laboratory facilities prevent their students' ability to engage fully in scientific concepts, for they are unable to verify theories by conducting experiments. Fernandez and Lopez (2022) corroborated this perspective, pointing out that those learners without access to laboratory facilities often develop misconceptions about different scientific principles because they cannot engage in practical learning. This gap in laboratory access emphasizes the importance of investing in laboratory resources, particularly in rural areas like the Balicuatro Area, Division of Northern Samar, to ensure that all students will have the chance to participate in hands-on scientific education.

The gap between the developing countries and the first world countries in terms of laboratory infrastructures was studied by UNESCO (2021). It is reported that those countries that are underdeveloped tend to have a low science literacy rate and disinterest in STEM careers. This phenomenon was attributed to the insufficient laboratory facilities in the region, which underscores the need for funding. In order to have a quality science education, the government of this region must emphasize investing in laboratory facilities to guarantee their learners' educational equity.

Various researchers offer alternative methods to complement traditional laboratory activities through virtual laboratories and mobile science units. Wilson (2020) proposed that these alternatives could be effective in the absence of physical laboratory facilities. Through the science mobile unit and virtual laboratory facilities, students are able to engage in interactive, real-world experiments. Miller and Tanner (2022) supported this method and claimed that this digital simulation will be able to help students interact with complex scientific concepts even in the absence of physical laboratory facilities. Zhao and Tan (2023) reinforced that technology-based laboratory simulations can improve students' knowledge of various challenging scientific principles.

Impact of Science Laboratories on Student Learning Outcomes

Various types of research displayed a considerable impact that science laboratory facilities have on the academic outcomes of the learner, specifically when addressing cognitive and non-cognitive skills. In the investigation by Smith and Jones (2020), they found that students who are fully engaged in laboratory experiments showed superior problem-solving abilities and high academic outcomes compared with the students who are confined to textbook-based learning. Their study discovered that laboratory activities give students the opportunity to test hypotheses, observe outcomes, and draw conclusions by employing a deep knowledge of scientific principles. The application of learning in practical settings, creating abstract concepts, and grasping scientific concepts easily is the product of hands-on learning and engagement. Active participation in laboratory experiments connecting to the theoretical framework was seen by Garcia and Lee (2019) as an important tool in making learning significant.

The development of essential non-cognitive skills is one of the many benefits of laboratory-based learning. Brown et al. (2021) further analyzed the effect of group experiments on learners' engagement, communication and scientific rationalization. The findings of their research showcased that students who participate in team activities during laboratory activities build stronger teamwork and communication skills as they engage in problem-solving and exchanging ideas. Johnson and Wells (2022) emphasized that the experience during the laboratory activities encourages learners to assess experimental data and solve particular issues, boosting their analytical and critical thinking skills. Their study revealed that students in laboratory-based settings were good at handling unfamiliar situations and handling complex scientific concepts with critical thinking and troubleshooting abilities.

Challenges in Science Laboratory Facilities and Teacher Support

Even though there are many benefits obtained from laboratory-based instruction, various important challenges obstruct the implementation in different educational settings. Inadequate funding and outdated facilities were identified by Hernandez and Lopez (2022) as the primary obstacles to the implementation of enhanced infrastructure in rural areas. The difficult delivery of effective science education is seen by Tiedeman (2021) as an obstacle to fully engaging the students with scientific concepts in the easiest and most meaningful way.

UNESCO (2021) delved deeper into the unequal distribution of laboratory resources, emphasizing that imbalance worsens educational disparities. The study stated that schools in first-world countries have more access to advanced technology and equipment, but those in developing countries are left lacking and outdated. Proper investment in laboratory facilities should be advocated in order to fill the gap and promote comprehensive science education.

Insufficient training for science teachers is one of the important obstacles that needs to be addressed. According to Anderson and Kim (2021), many teachers who come from under-resourced schools lack training in laboratory-based instruction. The absence of professional development among science teachers limits their ability to have efficient laboratory activities and leaves students restricted from exploring the wonders of the science world, as claimed by McClure (2021). Green et al. (2020) and McNeely & Desrochers (2021) reported that a comprehensive training program for science teachers should concentrate on both laboratory strategies and laboratory-based pedagogical skills to improve the quality of science education. The training program intended for the science teacher is essential, as claimed by Liu and Kou (2022), for it enhances student engagement and secures laboratory-based instruction as a vital part of the science curriculum. As stated by Reiser and Bell (2020), collaboration and sharing of the best practices among teachers are necessary for the improvement of effective inquiry-based laboratory tasks. The suggestion of Osborne et al. (2020) on collaboration among science teachers is important to offer opportunities to make materials and strategies to upscale science education.

Synthesis

This review of related literature points out the important role of science laboratory facilities in the enhancement of teachers' pedagogical abilities and promotes students' hands-on knowledge. The promotion of experiential learning lies with the fully equipped laboratories, which enable students to foster scientific inquiry and develop critical thinking skills. On the other hand, public senior high schools in rural areas like the Balicuatro Area, Northern Samar Division often face predicaments like the absence of laboratory infrastructure, limited resources and low maintenance of equipment that leads to poor science education. Different research revealed that the availability of standard laboratory facilities allowed teachers to use and adopt inquiry-based strategies and facilitated hands-on activities. Regardless of the importance of science laboratory infrastructure, a disparity in research is still present, assessing their direct effect on teaching strategies, specifically in rural settings like the Balicuatro Area. This study sought to fill the gap through the exploration of the availability and adequacy of laboratory facilities with the instructional methods of public Senior SHS- teachers for the purpose of appraising educational infrastructures and teaching strategies.

- Statement of the problem

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This research sought to identify the pedagogical skills through laboratory-based instruction and their relationship to the current status of the science laboratory facilities in public senior high schools within the Balicuatro Area Division, Northern Samar.

Specifically, this aimed in answering the following;

1. What is the demographic profile of the SHS Science teachers and school heads in terms of:

   1.1 Age
   1.2 Sex
   1.3 Civil Status
   1.4 Position
   1.5 Years of Teaching

2. What is the level of pedagogical skills in laboratory-based instruction of senior high school science teachers and school heads in terms of:
   2.1 Instructional strategy
   2.2 Classroom management
   2.3 Laboratory-based teaching methods

3. What is the assessment of the respondents on the current status of science laboratory facilities in public senior high schools in the Balicuatro Area, Northern Samar Division, in terms of:
   3.1 Adequacy of Science Laboratory Facilities
   3.2 Utilization & Engagement
   3.3 Safety & Standards

4 Is there a significant relationship between the level of pedagogical skills of the respondents and the laboratory-based instruction when grouped according to their profile?

5 Is there a significant difference between the respondents' assessment of the current status of science laboratory facilities and their level of pedagogical skills in laboratory-based instruction?

6 Based on the research findings, what action plan may be recommended?

- Objectives and/or research hypotheses

  Science laboratory facilities performed a vital role in the improvement of the pedagogical skills of SHS science teachers and school heads. Effective laboratory handling requires both adequate infrastructure and well-developed teaching strategies to facilitate hands-on learning. This study examined the relationship between laboratory facilities, teacher and school heads' competencies, and respondent profiles in science education within the Balicuatro Area Division, Northern Samar.

  To test these relationships, the study proposes the subsequent null hypotheses:

- There is no significant relationship between the pedagogical skills of Senior High School science teachers and school heads when grouped according to their profile.

- There is no significant relationship between the adequacy and utilization of science laboratory facilities and the pedagogical skills of Senior High School science teachers and school heads.

2. Materials and Methods

- **Research Design:** Descriptive-Correlational
- **Participants:** Purposive sample of 67 SHS Science Teachers and School Heads
- **Instruments:** Validated Likert scale questionnaires
- **Procedure:** The researcher sought formal permission from the DepEd Regional Director before administering the questionnaire. Upon approval, the researcher distributed the survey questionnaires to the identified respondents for data collection
- **Data Analysis:** The data collected were analyzed using descriptive statistics (including mean, frequency, and percentage) to summarize the responses; Pearson correlation to determine the relationship between variables; and ANOVA (Analysis of Variance) to identify significant differences among groups.

3. Results

The presentation, interpretation, and analysis of the collected data are presented in this chapter in connection with the problem statement. Results were systematically arranged to address each specific research question, providing a thorough knowledge of the result of this research on the pedagogical skills through laboratory-based instruction and its relations to the current situation of the laboratory facilities in science at the public Senior High Schools in Balicuatro Area, Northern Samar Division. Data are presented through tables, figures, and descriptive analysis to highlight significant patterns, relationships, and implications relevant to the investigation.

Problem Number 1: What is the demographic profile of the SHS-Science teachers and head of schools in terms of age, sex, civil status, position and years of teaching?

Table 1

Distribution of the Profile of the Respondents in Terms of Age

Age	Frequency	Percent
21–30 years old	13	19.4
31–40 years old	22	32.8
41–50 years old	14	20.9
51 years old and above	18	26.9
Total	67	100.0

Table 1 illustrates the profile statistics of participants according to age. The data shows that a large portion of the participants were under the age bracket of 31-40 years old, with 22 (32.8%) of the respondents. Followed by those under 51 years old and above age bracket having 13 (26.9%). The respondents, the age 41-50 years old group, are composed of 14 (20.9%) individuals, and lastly, those who are under 21-30 years old with 13 (19.4%) SHS-science teachers and heads of schools.

The age profile of the participants showed that a notable portion of the Senior High School educators and school heads of schools in Northern Samar Division are in their mid-career stage, which suggests a workforce with significant classroom experience and substantial professional service. UNESCO

(2021) states that mid-career educators are most likely to adapt instructional innovations that could bridge traditional and modern practices. Their presence is important in the implementation and innovations of laboratory-based instruction in science.

The 18 respondents who are under the 51 and above age bracket create more than one-fourth of the total sample of the respondents, suggesting a strong institutional knowledge and mentoring potential. But the DepEd (2023) states that while these older teachers often show classroom management skills, they are in dire need of professional development to fully integrate with the 21st-century science teaching strategies to include laboratory-based instruction, which is also observed in the Balicuatro Area, Division of Northern Samar. Those teachers under the 21-30 years old bracket are classified as proficient teachers or beginner teachers by the Department of Education. Based on the OECD (2020), these beginner teachers often show enthusiasm and openness in using technology and a student-centered approach, but they need to be mentored and supported properly in order to apply scientific skills in laboratory settings.

The respondent's age profile illustrates a balanced distribution of generational teaching experiences. This heterogeneity supports a collaborative professional setting that, if well-managed, will improve the pedagogical abilities of SHS science teachers and school heads within the Balicuatro Area, Division of Northern Samar.

Table 2
Distribution of the Profile of the Respondents in Terms of Sex

Sex	Frequency	Percent
Male	19	28.4
Female	47	70.1
Prefer not to say	1	1.5
Total	67	100.0

In Table 2, the sex profile of the respondents in the Balicuatro Area, Northern Samar Division, is unfolded. There are predominantly female respondents with a frequency of 47 or 70.1% of the total sample size, followed by male respondents with 19 respondents, which comprised 28.4 percent and prefer not to say, with 1 respondent making 1.5% of the total sample size.

The gender grouping scenario in the Balicuatro Area is consistent with the current situation at both the national and international levels, where teachers at the elementary and secondary levels are predominantly composed of the female workforce. According to Word Bank (2022), there are 71.5 % of female secondary teachers in the Philippines, while globally, there are 54% of female secondary teachers according to UNESCO (2023), further strengthening the data result taken from the public SHS-science teachers and heads of schools in Balicuatro Area.

The high numbers of SHS science educators and school heads may not affect the delivery of science instruction through laboratory-based instruction due to the different aspects, such as the inadequacy of facilities and resources. It is emphasized by OECD (2020) that sex does not significantly affect the efficacy and efficiency of teachers. Further, it recognized the role of female teachers in demonstrating strong interpersonal and management skills necessary in implementing hands-on science laboratory-based teaching methods. While there is a smaller percentage of male respondents, as reflected in the data, they have a significant role in minimizing the continuing gender stereotyping in the teaching profession. The unequal sex profile needs to be addressed in order to achieve gender equity and a sense of diversity in delivering instruction to students in the said setting.

Table 3
Distribution of the Profile of the Respondents in Terms of Civil Status

Civil Status	Frequency	Percent
Single	17	25.4
Married	43	64.2
Widow	7	10.4
Total	67	100.0

Table 3 presents the demographic distribution by civil status of the study participants. The result shows that most of the SHS-Science teachers and school heads are married, to 43 respondents (64.2 %). Followed by single with 17 individuals (25.4%). Lastly, the widowed respondents, with 7 respondents (10.4%), comprise the smallest civil status group.

Results illustrate the dominance of married respondents in the Balicuatro Area, Division of Northern Samar, in which most of the educators are in their mid-life stages and most likely to have career stability. When it regards marital status, Erden et al. (2023) perceived that there is a low direct effect on the teaching ability of the respondents, further their study points out that married teachers and school heads are most likely to be consistent, collaborative, organized and discipline when it comes to the workplace. These qualities are very important in promoting strong pedagogical skills in laboratory-based instruction in the Balicuatro Area, Northern Samar Division.

The single group, which comprised 25.4 %, represents a younger or early career demography, is seen to be new professionals and are new to the teaching profession. Meanwhile, those who are widowed, 10.4% of the respondents, are educators who are experienced and still in service despite their personal life challenges, which suggests resiliency. In totality, married teachers and school heads may benefit from programs and policies promoting work-life balance, whereas those who are single and widowed may have development programs intended for specific needs.

Table 4
Distribution of the Profile of the Respondents in Terms of Position

Position	Frequency	Percent
Teacher I	8	11.9
Teacher II	37	55.2
Teacher III	7	10.4
Principal I-IV	15	22.4
Total	67	100.0

Table 4 presents the professional position profile of the respondents. The statistics indicate that the majority of the participants of the study in Balicuatro Area, Division of Northern Samar are Teacher II at 55.2%, followed by Principal I-IV at 22.4%, then by Teacher I at 11.9%, and Teacher III at 10.4%. The dominance of Teacher II in the Area was the result of mass recruitment during the implementation of the K12 Program.

The result shows that most of the respondents fall under mid-level educators. SHS-Science teachers in Balicuatro Area, Division of Northern Samar, remain in the Teacher II position for 5 years or more because of the absence of a career progression path specifically for the Senior High School. This data was very important in giving realistic insight into their roles, responsibilities and pedagogical skills.

Furthermore, the Department of Education (2020) stated that the Teacher II position was typically given to teachers who are consistent with their professional growth and performance.

The dominance of the Teacher II position in Balicuatro Area, Division of Northern Samar, aligns with the objective of this study in identifying the pedagogical abilities of the SHS-Science teacher and heads of school in relation to the laboratory facilities. According to SEAMEO INNOTECH (2021), this issue indicates a strong pool of experienced science teachers and school heads who remained in their respective positions without any higher-level transition because of the structural limitation in career progression.

In addition, UNESCO (2023) stated that career mobility and capacity building in the leadership component for the said educators are important aspects for the sustainability of quality education, specifically for rural areas like the coastal and island municipalities in Balicuatro Area, Northern Samar Division.

Table 5
Distribution of the Profile of the Respondents in Terms of Teaching Experience

Years of Teaching Experience	Frequency	Percent
Less than 1 year	4	5.7
1-3 Years	30	42.9
4-5 Years	18	25.7
7 Years and above	15	21.4
Total	67	95.7

Table 5 unveils the years in teaching profile of SHS-Science teachers and heads of schools in the Balicuatro Area, Division of Northern Samar. The data reveals that a large number of the participants' years of teaching experience are in the early stage of their career, with 1 to 3 years of experience, with 30 individuals comprising 42.9%. Followed by those 18 teachers and school heads who have been teaching for 4 to 5 years, having 25.7%. Teachers and school heads who have been teaching for more than 7 years are 15 with 21.4%. Lastly, respondents who have 1 year or less teaching experience are composed of 4 individuals or 5.7%. The result suggests that a significant number of the SHS-Science teachers and heads of schools are in their mid-career stages.

The dominance of teachers in the early-career stage has pedagogical implications, specifically in the delivery and how laboratory facilities are being used. UNESCO (2022) described that beginner science educators show eagerness to participate in hands-on and inquiry-based teaching methods, but facing challenges is inevitable if there is a lack of laboratory facilities and consistent practice of pedagogical skills in laboratory-based instruction. This situation is currently experienced by different SHS-Science teachers and school heads in the Balicuatro Area, Northern Samar Division.

The 21.4% of the Principal I-IV position who have served for 7 years and above depicts that the concern on the lack of laboratory infrastructure in the Area was a long-standing concern. Their years of service suggest that the lack of science resources has persisted for multiple academic years, affecting the integrity of science instruction within the region. This outcome aligns with the findings of Hadji Abas and Marasigan (2020), which state that inadequate laboratory facilities affect the performance tasks in public junior high schools. Also, Mandarin and Macayana (2024) point out that limited budget and underfunding are the top reasons for the lack or absence of science infrastructure and equipment in Philippine public schools.

The data on the distribution of teaching experience in the Balicuatro Area, Division of Northern Samar, implies a picture of the workforce in transition. Moreover, the results affirm that significant teaching experience enhances instructional strategies and competence and allows educators to master their pedagogical strategies and classroom management skills over some time. Mastery for Salandanan (2020) is a byproduct of prolonged engagement in teaching.

Problem Number 2: What is the level of pedagogical skills in laboratory-based instruction of senior high school science teachers and school heads in terms of instructional strategies, classroom management and laboratory-based teaching methods?

Table 6
Instructional Strategies of Senior High School Science Teachers and School Heads in Laboratory Based Instruction at Balicuatro Area, Division of Northern Samar

Instructional Strategies	Mean	Interpretation
Use a variety of instructional strategies in the laboratory to cater to different learning styles.	1.75	Occasionally Applied
Provide guided inquiry opportunities to help students explore scientific concepts in the lab.	1.76	Occasionally Applied
Use collaborative learning strategies, such as group work, during laboratory experiments.	1.76	Occasionally Applied
Guide students through structured problem-solving tasks that promote critical thinking.	1.82	Occasionally Applied
Frequently incorporate multimedia tools (e.g., videos, simulations) to enhance laboratory learning.	1.61	Occasionally Applied
Set clear objectives for laboratory experiments before each activity.	1.72	Occasionally Applied
Vary the types of laboratory activities based on the concept being taught.	1.52	Rarely Applied
Regularly assess students' laboratory skills through formative assessments.	1.48	Rarely Applied
Provide real-world applications of scientific principles during laboratory sessions.	1.51	Rarely Applied
Encourage students to reflect on their laboratory experiences and discuss findings.	1.52	Rarely Applied
Actively engage students in designing their own experiments during laboratory activities.	1.49	Rarely Applied
Adapt my teaching strategies depending on the complexity of the experiment.	1.46	Rarely Applied

Utilize hands-on learning to ensure that students can apply theoretical knowledge in practical settings.	1.60	Rarely Applied
Use flexible instructional approaches to support all students' learning needs.	1.37	Rarely Applied
Use varied and engaging assessment strategies to reinforce student learning	1.48	Rarely Applied
Grand Mean	**1.59**	**Rarely Applied**

Table 6 demonstrates the pedagogical skills of the participants' instructional strategies. The result shows that the 15 indicators have a mean ranging from 1.37 to 1.82, based on the scale it is interpreted from "Rarely Applied to Occasionally Applied". The highest mean rating of 1.82 (Occasionally Applied) was derived from "Guide students through structured problem-solving tasks that promote critical thinking" and perceived as "sometimes". On the other hand, the lowest mean in the instructional strategies was 1.37, which is interpreted as "Rarely Applied" and lies in "Use flexible instructional approaches to support all students' learning needs". Generally, the computed grand mean for the instructional strategies is 1.59, which suggests that the SHS-Science teachers and heads of schools in Balicuatro Area, Northern Samar Division, rarely apply instructional strategies on laboratory-based instructions.

The findings depict the current pedagogical abilities of the SHS-Science teachers and heads of schools, which are most likely affected by laboratory facilities and equipment. Torres and Dizon (2021) concurred that limited access to standard laboratory facilities, instructional resources, insufficient laboratory equipment, and large class sizes often constrain the pedagogical practices in public schools. In spite of the challenges, science teachers and school heads are taking some steps to integrate varied instructional strategies in laboratory-based instruction. Most of the Senior High Schools in the Balicuatro Area are using classrooms as a temporary laboratory facility to cater to the competencies required by the Department of Education.

The highest-rated item was "Guide students through structured problem-solving tasks that promote critical thinking," with a mean of 1.83 categorized as "Occasionally Applied", suggests that both SHS-Science teachers and heads of a school recognized the value of such strategies in enhancing critical thinking skills (Putri et al., 2025). In addition, the indicators "Provide guided inquiry opportunities to help students explore scientific concepts in the lab" and "Use collaborative learning strategies, such as group work, during laboratory experiments," both having a mean of 1.76, both interpreted as "Occasionally Applied". Aligned with the findings of Chengere et al. (2025), guided inquiry-based laboratory activities improve students' science process skills.

Conversely, the indicator "Use flexible instructional approaches to support all students' learning needs," having a mean of 1.37 "Rarely Applied," suggests a limited implementation of differentiated instructional strategies. The result of the study of Damyanov (2024) highlights the importance of flexible pedagogical strategies. Thus, instructional strategy and well-equipped laboratory facilities are important components in developing pedagogical skills in laboratory-based instruction.

Table 7
Classroom Management of Senior High School Science Teacher in Laboratory Based Instruction at Balicuatro Area, Division of Northern Samar

Classroom Management	Mean	Interpretation

Maintain a clear set of rules and expectations for student behavior in the laboratory.	1.51	Poor
Effectively manage student behavior during laboratory activities.	1.61	Satisfactory
Provide clear instructions and expectations for each laboratory experiment.	1.78	Satisfactory
Use positive reinforcement to encourage student engagement and cooperation in the laboratory.	1.76	Satisfactory
Proactively address disruptive behavior during laboratory sessions.	1.87	Satisfactory
Create a safe environment for students to experiment and learn.	3.91	Exemplar
Establish routines to ensure smooth transitions between different phases of the laboratory session.	1.90	Satisfactory
Set clear time limits for each laboratory activity to ensure timely completion.	1.46	Poor
Encourage student participation and engagement throughout the laboratory session.	2.16	Satisfactory
Maintain effective communication with students to ensure they understand the objectives and steps of experiments.	1.94	Satisfactory
Address safety concerns and enforce safety rules during laboratory activities.	2.24	Satisfactory
Ensure that students work collaboratively and productively in the laboratory.	2.09	Satisfactory
Allocate roles within groups to ensure all students participate actively in laboratory work	1.81	Satisfactory
Manage classroom resources efficiently to minimize waste during laboratory activities.	1.80	Satisfactory
Use seating arrangements effectively to foster collaboration and safety in laboratory activities.	1.73	Satisfactory
Grand Mean	**1.97**	**Satisfactory**

Table 7 illustrates the classroom management demonstrated by SHS-Science teachers and heads of school Balicuatro Area, Northern Samar Division, specifically during laboratory-based instruction. The mean ratings for the 15 indicators range from 1.46 to 3.91, with a computed grand mean of 1.97. Based on the interpretation scale used in this study, this was categorized as "Satisfactory", implying that even though most SHS-Science teachers and school heads are proficient in managing laboratory sessions, several areas still require targeted improvement and support.

The highest-rated indicator, "Creating a safe environment for students to experiment and learn" (M = 3.91), reflects a strong emphasis on safety practices among science teachers. This finding corresponds with the DepEd 2023 directive in prioritizing students' safety in different science-related activities. It also resonates with international perspectives, such as those of the OECD (2021), which underscore the importance of establishing safety protocols—particularly in resource-constrained educational settings—to foster student engagement while minimizing risk.

Conversely, the two lowest-ranked indicators— "Setting clear time limits in each laboratory activity" (M = 1.46) and "Maintaining consistent rules and behavioral expectations" (M = 1.51)—were both rated as "Poor." These findings highlight significant challenges related to time management and classroom discipline, which are essential components of effective laboratory instruction. The low ratings may be attributed to the complexity of supervising practical activities within large class sizes or with limited teaching personnel.

Meanwhile, moderate ratings were observed in fields like "Encouraging student participation," with a mean of 2.16 and "Enforcing safety procedures," having a mean of 2.24, indicating some positive practices are in place but are not yet consistently applied across all laboratory sessions. Further, This reflects a need for a more systematic implementation of classroom discipline techniques.

Overall, the findings point towards the necessity of sustained institutional support. SHS-Science teachers and school heads in Balicuatro Area, Northern Samar Division, continue to face systemic limitations, including overcrowded classrooms, inadequate laboratory resources, and the absence of specialized seminars in laboratory-focused teaching. To improve classroom management performance in science laboratories, there is a clear need for localized in-service training programs, peer mentoring initiatives, and enhanced resource allocation. The school administration should advocate the improvement and or construction of laboratory facilities in local government units and other private sectors. These interventions help shift the level of practice from satisfactory to more effective and professional standards.

Table 8
Laboratory Based Teaching Methods of Senior High School Science Teacher and School Heads in Laboratory Based Instruction at Balicuatro Area, Division of Northern Samar

Laboratory Based Teaching Methods	Mean	Interpretation
Use hands-on experiments to facilitate active student learning in the laboratory.	1.55	Seldom Practiced
Integrate technology (e.g., computers, virtual labs) to enhance laboratory experiences.	1.40	Seldom Practiced
Encourage students to perform experiments that test their own hypotheses.	1.57	Seldom Practiced
Regularly use lab reports to assess student understanding of experiments.	1.42	Seldom Practiced
Ensure that laboratory work aligns with the learning objectives of the curriculum.	1.60	Seldom Practiced
Use lab-based activities to reinforce theoretical concepts taught in class.	1.42	Seldom Practiced

Provide ample opportunity for students to ask questions during laboratory sessions.	1.49	Seldom Practiced
Implement guided inquiry-based experiments to foster critical thinking in the laboratory.	1.55	Seldom Practiced
Use collaborative projects to encourage teamwork and problem-solving in the lab.	1.58	Seldom Practiced
Promote independent student inquiry and self-directed learning during laboratory work.	1.57	Seldom Practiced
Regularly provide feedback on students' laboratory performance.	1.81	Sometimes Practiced
Use a variety of assessments (e.g., quizzes, practical exams) to evaluate student laboratory skills.	1.51	Seldom Practiced
Encourage students to conduct research and experiments that extend beyond the curriculum.	1.51	Seldom Practiced
Create laboratory experiments that require students to analyze real-world scientific issues.	1.58	Seldom Practiced
Incorporate case studies and simulations to demonstrate laboratory-based principles.	1.39	Seldom Practiced
Grand Mean	**1.53**	**Seldom Practiced**

Table 8 shows the current state of laboratory-based teaching methods used by SHS-Science teachers and school heads in Balicuatro Area, Northern Samar Division. The mean scores for the 15 indicators ranged from 1.39 to 1.81, with an overall average of 1.53. According to the scale adopted in this study, this falls under "Seldom Practiced."

This study showed that although laboratory-based methods are present, their integration into classroom teaching remains limited. Thus, it is understandable, given the challenges faced by many public schools in the Area—such as inadequate laboratory facilities, outdated scientific equipment, and crowded classrooms. These conditions are common in rural parts of the Philippines, and they affect how fully teachers can apply hands-on learning techniques. While teachers and school heads are making some effort, these are still not enough to meet the goals of the Basic Education Science Curriculum (K12), which emphasizes student-focused and inquiry-driven teaching (Department of Education, 2023).

The highest-rated item was "Regularly provide feedback on students' laboratory performance," with a mean of 1.81("Sometimes Practiced). Further, this suggests that teachers value giving students timely feedback to support their learning, which is an important part of effective teaching—even when resources are scarce. The indicators, such as "encouraging teamwork through collaborative projects" and "designing experiments that relate to real-world problems" (both with a mean of 1.58), show that some attempts are being made to engage students in critical thinking, although these are still limited in practice.

On the other hand, some methods are rarely used. For example, "Incorporate case studies and simulations" (M = 1.39) and "Use technology such as virtual labs" (M = 1.40) scored the lowest, both under the category of seldom practiced, highlighting a gap in digital resources and innovative teaching tools. The study also found low scores for encouraging students to conduct independent research and linking lab work to theoretical lessons, which are important for deepening understanding.

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Overall, this study showed that SHS-Science teachers and heads of schools in the Balicuatro Area, Northern Samar Division, recognized the importance of laboratory teaching, but they faced many obstacles in fully applying these methods. To improve, targeted training on inquiry-based learning and better access to lab equipment and technology will be needed. Institutional support is also essential to help schools move toward more meaningful hands-on science education**.**

Problem No. 3 What is the assessment of the respondents on the current status of science laboratory facilities in public senior high schools in the Balicuatro Area, Northern Samar Division, in terms of adequacy of science laboratory facilities, utilization & engagement and safety & standards?

Table 9

Adequacy of Science Laboratory Facilities of Senior High School in Balicuatro Area, Division of Northern Samar

Adequacy of Science Laboratory Facilities	Mean	Interpretation
The school has an adequate number of laboratory rooms for science classes.	1.27	Not Adequate
The available laboratory rooms are sufficiently equipped to function independently from regular classrooms.	1.30	Not Adequate
The laboratory layout provides sufficient space and furnishings to support collaborative and safe student activities.	1.28	Not Adequate
The laboratory layout provides sufficient space and furnishings to support collaborative and safe student activities.	1.33	Not Adequate
Storage cabinets and shelves are sufficient for laboratory materials.	1.55	Not Adequate
Safety equipment (e.g., fire extinguishers, safety goggles) is available in sufficient quantities.	1.34	Not Adequate
The laboratory is adequately ventilated and illuminated.	1.54	Not Adequate
There are sufficient chemical reagents and biological specimens for student experiments.	1.66	Somewhat Adequate
The laboratory has adequate water and electrical supply for conducting experiments.	1.51	Not Adequate
The number of available microscopes and other precision instruments is adequate.	2.19	Somewhat Adequate
Grand Mean	**1.50**	**Not Adequate**

Table 9 shows the perceived adequacy of scientific laboratories in Senior High Schools across the Balicuatro Area, Northern Samar Division. Based on the responses of the respondents to ten indicators, the mean scores ranged from 1.27 to 2.19, falling on the "Not Adequate" to "Somewhat Adequate" category. The perceived grand mean for adequacy is 1.50, which was categorized as "Not Adequate". The finding suggests that science laboratories in the Area are generally insufficient to support effective laboratory-based teaching. The lack of adequate infrastructure is especially clear in aspects like the number of laboratory rooms available (M = 1.27), the size and layout of lab spaces to safely accommodate students (M = 1.28), and the ability of labs to operate independently from regular classrooms (M = 1.30). These issues seriously limit the quality of science education in these coastal and island schools in the Balicuatro Area.

Additionally, the availability of basic laboratory equipment (M = 1.33), safety gear (M = 1.34), storage facilities for materials (M = 1.55), and utilities like water and electricity (M = 1.51) were also rated poorly. Problems with ventilation and lighting (M = 1.54) suggest poor working conditions that could affect both teachers' and students' health and safety. The only areas that were rated as "Somewhat Adequate" were the supply of chemical reagents and biological specimens (M = 1.66) and the number of microscopes and precision instruments (M = 2.19). However, these resources alone are not enough to create a fully functional lab environment. It is also noted that among these schools, there is only 1 school that does have a standard laboratory facility that caters to more than 300 students per day.

The challenges revealed in this study reflect the broader geographical and socio-economic context of the Balicuatro Area, which is made up mostly of coastal and island municipalities. These communities face ongoing difficulties with infrastructure development, transportation, and access to educational resources. Previous studies, such as Bautista (2020), have documented how rural science educators in the Philippines often deal with limited materials, poorly maintained facilities, and irregular opportunities for laboratory instruction. Similarly, Torres and Dizon (2021) noted that remote schools frequently rely on makeshift lab setups, which undermine educational effectiveness.

This research also demonstrated that the inadequacy of laboratory facilities likely affects teachers' pedagogical skills. Earlier analysis showed a modest but statistically significant correlation between laboratory adequacy and teaching skills ($r = 0.265$, $p = 0.030$), suggesting that improving lab conditions could help enhance instructional quality. These findings align with UNESCO (2022), which highlights how quality laboratory environments boost teachers' ability to deliver effective science lessons.

In summary, this study showed a clear need for systemic investment in science laboratory infrastructure in the Balicuatro Area, including building dedicated laboratory rooms with standard equipment and safety tools, ensuring access to utilities, and maintaining a steady supply of consumables. These improvements are vital for meeting the goals of the Basic Education Science curriculum (K12), which seeks to develop scientific inquiry, critical thinking, and practical skills throughout Filipino students (Department of Education, 2023).

Table 10
Utilization and engagement of Laboratory Facilities in Senior High School in Balicuatro Area, Division of Northern Samar

Utilization and engagement	Mean	Interpretation
Regularly conduct laboratory-based experiments in my science classes	1.30	Limited
Effectively integrate laboratory activities with theoretical instruction.	1.30	Limited
Students actively participate in hands-on experiments.	1.48	Limited
Encourage students to conduct independent laboratory investigations.	1.54	Limited

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Utilize virtual or simulated laboratory experiments when resources are limited.	1.63	Moderate
Students conduct group-based laboratory work.	1.45	Limited
Assess students' skills in laboratory procedures.	1.43	Limited
Learning and Engagement laboratory activities enhance students' scientific skills and critical thinking.	1.61	Moderate
Schedule laboratory sessions based on the curriculum requirements.	1.43	Limited
Laboratory work fosters students' interest in science subjects.	1.52	Limited
Grand Mean	**1.47**	**Limited**

Table 10 presents the data on how SHS-Science teachers and heads of schools in the Balicuatro Area, Northern Samar Division, utilize and engage students through laboratory facilities during the instructional process. The results reveal that the mean values for the ten indicators vary between 1.30 - 1.63. The computed grand mean for utilization and engagement is 1.47 and categorized as "Limited". Despite the presence of some laboratory facilities (as discussed in Table 9), their actual use in classroom instruction remains significantly constrained.

The lowest-rated items, "Regularly conduct laboratory-based experiments in my science classes" (M = 1.30) and "Effectively integrate laboratory activities with theoretical instruction" (M = 1.30), reflect a minimal integration of practical science work into day-to-day instruction. These findings support previous literature indicating that public schools in rural areas often struggle to provide experiential science education due to limited access to functional laboratory spaces, time constraints, and an overburdened teaching load (Torres & Dizon, 2021; UNESCO, 2022). Likewise, student engagement metrics such as "Students actively participate in hands-on experiments" (M = 1.48), "Students conduct group-based laboratory work" (M = 1.45), and "Laboratory work fosters students' interest in science subjects" (M = 1.52) were rated within the "Limited Utilization" category. These low values suggest that even when facilities are available, the design and implementation of engaging laboratory experiences remain insufficient, which could stem from a combination of factors, including large class sizes, lack of instructional planning support, and insufficient teacher training in laboratory pedagogy (Bautista, 2020).

Notably, two items— "Utilize virtual or simulated laboratory experiments when resources are limited" (M = 1.63) and "Learning and engagement in laboratory activities enhance students' scientific skills and critical thinking" (M = 1.61)—were classified under "Moderate Utilization." This data shows some degree of teacher initiative in compensating for physical resource gaps through technology-aided alternatives, as well as a recognition of the pedagogical value of laboratory-based instruction. However, items like "Encourage students to conduct independent laboratory investigations" (M = 1.54) and "Assess students' skills in laboratory procedures" (M = 1.43) indicate that assessment and inquiry-based learning practices are not fully institutionalized. These are critical elements in developing scientific reasoning and procedural knowledge among students, as advocated in the K to 12 Science Curriculum (DepEd, 2023).

Taken together, these findings indicate a notable disconnect between the potential and the actual use of laboratory facilities in science instruction. While some efforts are being made to integrate laboratory activities—especially through virtual alternatives—usage remains generally limited. This underutilization

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undermines the goals of developing inquiry skills, critical thinking, and interest in science among learners (NASEM, 2021).

To bridge this gap, the study recommends the implementation of targeted professional development programs for science teachers, focusing on laboratory management, integration of virtual labs, and learner-centered inquiry strategies. Additionally, enhanced instructional supervision and support from school leadership could promote more consistent and meaningful use of laboratory activities in science classes.

Table 11
Safety and Standards of Laboratory Facilities in Senior High School in Balicuatro Area, Division of Northern Samar

Safety and Standards Indicators	Mean	Interpretation
The laboratory has clear safety guidelines that are followed by both students and teachers.	1.42	Rarely Practiced
Proper labeling of chemicals and laboratory materials is followed.	1.48	Rarely Practiced
Emergency exits and evacuation plans are clearly marked in the laboratory.	1.40	Rarely Practiced
Safety protocols for handling hazardous materials are strictly enforced.	1.45	Rarely Practiced
The laboratory has appropriate fire safety measures (e.g., fire extinguisher, fire blankets).	1.54	Rarely Practiced
Regular maintenance and safety checks are conducted on laboratory equipment.	1.45	Rarely Practiced
First aid kits and medical supplies are readily accessible in the laboratory.	1.55	Rarely Practiced
Students are trained on the proper use of laboratory equipment and safety protocols.	1.64	Sometimes Practiced
There are sufficient personal protective equipment (PPE), such as gloves and goggles, for all students.	1.46	Rarely Practiced
The laboratory environment is free from physical hazards (e.g., exposed wires, sharp objects).	1.43	Rarely Practiced
Grand Mean	**1.48**	**Rarely Practiced**

Table 11 presents the statistical average ratings for ten key indicators of laboratory safety practices in Senior High Schools across the Balicuatro Area. The results reveal notable deficiencies, with scores varying from 1.40 to 1.64. The overall mean for the safety and standard is 1.48, indicating that safety measures are rarely practiced across the institutions surveyed.

The presence of clear and accessible safety guidelines for both teachers and students received a mean score of 1.42, while proper chemical labeling was slightly higher at 1.48. Emergency exits, a critical component of safety infrastructure, were poorly rated at 1.40. These findings suggest that fundamental safety practices are not adequately implemented. The enforcement of laboratory protocols also appears inconsistent. Procedures for handling hazardous materials and conducting equipment checks were rated at

1.45. While first aid kits were somewhat accessible (M = 1.55), the data do not confirm whether staff or students are trained in their use. Student safety training received the highest score among the indicators (M = 1.64) yet remains insufficient to ensure safe practice. Physical hazards persist due to inadequate lighting and cluttered spaces, reflected in a mean score of 1.43. Personal protective equipment, which is essential for lab safety, remains limited (M = 1.46). These figures align with findings from Reyes and Tolentino (2021), who observed similar challenges in rural Philippine schools, often tied to budget constraints and insufficient policy enforcement.

Overall, the results emphasize the need for targeted interventions in laboratory safety, including improved access to protective equipment, regular training sessions, and strict implementation of existing safety policies. Without these, both the effectiveness of science instruction and the safety of educational environments remain at risk.

Problem No. 4 Is there a significant relationship between the level of pedagogical skills of the respondents and the laboratory-based instruction when grouped according to their profile?

Table 12
Comparative Analysis of Assessment on the Respondents Level of Pedagogical Skills in Laboratory Based Instructions when Grouped According to Age

ANOVA							
Pedagogical Skills	Age	N	Mean	Interpretation	F	Sig	Decision
Instructional Strategies	21–30 years old	13	1.63	Occasionally Applied	.323	.809	Accept H_0 (Not Significant)
	31–40 years old	22	1.58	Rarely Applied			
	41–50 years old	14	1.60	Occasionally Applied			
	Above 51	18	1.56	Rarely Applied			
	Total	67	1.59	Rarely Applied			
Classroom Management	21–30 years old	13	2.05	Satisfactory	2.535	.065	Accept H_0 (Not Significant)
	31–40 years old	22	2.03	Satisfactory			
	41–50 years old	14	1.96	Satisfactory			
	Above 51	18	1.84	Satisfactory			
	Total	67	1.97	Satisfactory			
Laboratory Based Teaching Method	21–30 years old	13	1.53	Seldom Practiced	1.845	.148	Accept H_0 (Not Significant)
	31–40 years old	22	1.58	Seldom Practiced			

41–50 years old	14	1.55	Seldom Practiced
Above 51	18	1.46	Seldom Practiced
Total	67	1.53	Seldom Practiced

Presented in Table 12 was a comparative analysis of the participants' level of pedagogical abilities in laboratory-based instruction when classified based on age. The assessment focused on three domains: instructional strategies, classroom management, and laboratory-based teaching methods. Age categories were classified into 21–30, 31–40, 41–50, and 51 years old and above. Responses were measured using a 1.00–4.00 Likert scale with corresponding interpretation ranges.

In the Instructional Strategies domain, mean scores ranged from 1.56 to 1.63, falling under "Rarely Applied" to "Occasionally Applied". Teachers and school heads aged 21–30 and 41–50 showed slightly higher means, but the ANOVA result (F = 0.323, p = 0.809) reveals no significant differences among age groups. This finding supports the notion that the ability to deliver diverse instruction is more influenced by professional exposure than age alone, as stipulated by Rajput and Sharma (2025).

For Classroom Management, all age groups had mean scores from 1.84 to 2.05, interpreted as Satisfactory. Although younger educators (21–30) had the highest mean, the ANOVA result (F = 2.535, p = 0.065) indicates no significant variation among groups. This outcome aligns with the findings of Lestari et al. (2020), emphasizing that effective classroom management stems from mentorship, in-service training, and consistent implementation rather than demographic attributes.

The domain of Laboratory-Based Teaching Methods shows mean scores between 1.46 and 1.58, categorized as "Seldom Practiced". All age groups posted similar ratings, with the 31–40 group having the highest mean (1.58). The ANOVA result (F = 1.845, p = 0.148) confirms that there are no statistically significant differences based on age. This result suggests that limited access to resources and facilities may be a common challenge, regardless of age, echoing the findings of Ismail et al. (2021). Further, it emphasizes that the availability of different laboratory resources is important in the enhancement of the pedagogical skills of science educators.

The comparative analysis indicates that age does not play a significant role in determining the degree of pedagogical skills in laboratory-based instruction among SHS-Science teachers and heads of schools in the Balicuatro Area, Northern Samar Division. The consistent results across age groups highlight the importance of ongoing professional development and equitable access to instructional resources, as supported by Villena and Cabansag (2022), who stressed that pedagogical competence is shaped by ongoing support rather than age or position alone. Further, it accentuates the need for schools to institutionalize sustained learning opportunities and mentorship programs that improve instructional effectiveness across all experience levels.

Table 13
Comparative Analysis of Assessment on the Respondents Level of Pedagogical Skills in Laboratory Based Instructions when Grouped According to Sex

ANOVA							
Pedagogical Skills	**Sex**	**N**	**Mean**	**Interpretation**	**F**	**Sig**	**Decision**

Instructional Strategies	Male	19	1.56	Rarely Applied	.845	.434	Accept H_0 (Not Significant)
	Female	47	1.61	Occasionally Applied			
	Prefer not to say	1	1.40	Rarely Applied			
	Total	67	1.59	Rarely Applied			
Classroom Management	Male	19	1.93	Satisfactory	.925	.402	Accept H_0 (Not Significant)
	Female	47	1.99	Satisfactory			
	Prefer not to say	1	1.73	Satisfactory			
	Total	67	1.97	Satisfactory			
Laboratory Based Teaching Method	Male	19	1.52	Seldom Practiced	.093	.911	Accept H_0 (Not Significant)
	Female	47	1.53	Seldom Practiced			
	Prefer not to say	1	1.47	Seldom Practiced			
	Total	67	1.53	Seldom Practiced			

Table 13 illustrates the comparative findings of pedagogical skills in laboratory-based instruction among SHS-Science teachers and heads of schools in the Balicuatro Area, Northern Samar Division, when grouped according to sex. The assessment focused on three pedagogical domains: Instructional Strategies, Classroom Management, and Laboratory-Based Teaching Methods. Ratings were interpreted using a 1.00–4.00 Likert scale.

In the Instructional Strategies domain, mean scores for male (1.56), female (1.61), and undisclosed (1.40) respondents fell within "Rarely Applied to Occasionally Applied", with ANOVA results ($F = 0.845$, $p = 0.434$) showing no significant gender-based differences. This result suggests that instructional diversity is influenced more by training and context than gender (Aladwan et al., 2021). Similarly, in Classroom Management, males scored 1.93, females 1.99, and the undisclosed respondent 1.73—all rated "Satisfactory", with no significant difference ($F = 0.925$, $p = 0.402$), supporting Lestari et al. (2020) on the role of behavioral strategies over demographics. For Laboratory-Based Teaching Methods, scores were 1.52 (male), 1.53 (female), and 1.47 (undisclosed), all under "Seldom Practiced", with no significant difference ($F = 0.093$, $p = 0.911$), aligning with Ismail et al. (2021) that equitable access and training, not sex, drive hands-on teaching practices.

Furthermore, sex is not a significant factor in the assessment of pedagogical skills in laboratory-based instruction among science teachers in the Balicuatro Area. The consistency in results across male, female, and undisclosed sex respondents reflects the inclusive nature of science teaching competence. With continued professional development and institutional support, educators of any sex identity are equally capable of delivering effective instruction, managing classrooms, and integrating laboratory activities in science education.

Table 14

Comparative Analysis of Assessment on the Respondents Level of Pedagogical Skills in Laboratory Based Instructions when Grouped According to Civil Status

ANOVA							
Pedagogical Skills	**Civil Status**	**N**	**Mean**	**Interpretation**	**F**	**Sig**	**Decision**
Instructional Strategies	Single	17	1.58	Rarely Applied	0.467	0.629	Accept H_0 (Not Significant)
	Married	43	1.58	Rarely Applied			
	Widow	7	1.66	Occasionally Applied			
	Total	67	1.59	Rarely Applied			
Classroom Management	Single	17	1.98	Satisfactory	1.603	0.209	Accept H_0 (Not Significant)
	Married	43	1.94	Satisfactory			
	Widow	7	2.12	Satisfactory			
	Total	67	1.97	Satisfactory			
Laboratory Based Teaching Method	Single	17	1.53	Seldom Practiced	0.397	0.674	Accept H_0 (Not Significant)
	Married	43	1.52	Seldom Practiced			
	Widow	7	1.58	Seldom Practiced			
	Total	67	1.53	Seldom Practiced			

Table 14 illustrates the comparative analysis of the level of pedagogical skills in laboratory-based instruction among SHS-Science teachers and school heads in the Balicuatro Area, Northern Samar Division, when grouped according to civil status. The domains assessed include instructional strategies, classroom management, and laboratory-based teaching methods.

In terms of instructional strategies, single and married respondents both recorded a mean of 1.58, while widowed respondents had a slightly higher mean of 1.66. These scores range from "Rarely Applied to Occasionally Applied. The ANOVA result (F = 0.467, p = 0.629) reveals no statistically significant difference. Findings suggest that regardless of marital status, respondents apply similar instructional approaches in science teaching. Studies such as those by Valerio et al. (2020) emphasize that teaching effectiveness stems more from professional development and access to instructional resources than from personal demographic factors.

In the domain of classroom management, single respondents had a mean of 1.98, married respondents averaged 1.94, and widowed respondents scored 2.12. All scores fall under the "Satisfactory" interpretation. Despite the slightly higher mean among widowed teachers, the difference lacks statistical significance (F = 1.603, p = 0.209). These results support the view of Cruz and Santiago (2021), who assert that classroom management proficiency is cultivated through experience and mentorship—factors equally available across civil status groups in public school systems.

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Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 1 Issue 7 (2025)

For laboratory-based teaching methods, all three civil status groups—single (1.53), married (1.52), and widowed (1.58)—fell within the range of "Seldom Practiced". The ANOVA result (F = 0.397, p = 0.674) again shows no significant variation. Confirming that personal status has no substantial impact on the ability to deliver experiential and inquiry-based instruction. These findings align with research by Tamayo and Alipio (2022), who emphasized the importance of institutional support, equitable access to laboratory resources, and consistent training for all educators.

The results of this analysis affirm that civil status is not a significant factor influencing the pedagogical skills of SHS-Science teachers and heads of schools in laboratory-based instruction. Whether single, married, or widowed, the respondents demonstrated comparable levels of competence across all instructional domains assessed, including instructional strategies, classroom management, and laboratory-based teaching methods. This consistency highlights the role of institutional support, continuous professional development, and collegial collaboration in enhancing teaching competencies. In the context of the Balicuatro Area in the Northern Samar Division, where resources may be limited, and laboratory facilities are often underdeveloped, the reliance on shared teaching strategies, peer modeling, and district-led training programs become even more critical. The findings align with global frameworks such as those from the OECD (2020), which emphasize the value of professional learning communities, and national policies like DepEd Order No. 42, s. 2023, which promotes quality instruction through teacher collaboration and school-based training.

Table 15
Comparative Analysis of Assessment on the Respondents Level of Pedagogical Skills in Laboratory Based Instructions when Grouped According to Position

ANOVA							
Pedagogical Skills	**Position**	**N**	**Mean**	**Interpretation**	**F**	**Sig**	**Decision**
Instructional Strategies	Teacher I	8	1.48	Rarely Applied	.926	.434	Accept H_0 (Not Significant)
	Teacher II	37	1.60	Occasionally Applied			
	Teacher III	7	1.61	Occasionally Applied			
	Principal I–IV	15	1.60	Occasionally Applied			
	Total	67	1.59	Rarely Applied			
Classroom Management	Teacher I	8	1.92	Satisfactory	1.314	.278	Accept H_0 (Not Significant)
	Teacher II	37	2.01	Satisfactory			
	Teacher III	7	2.05	Satisfactory			
	Principal I–IV	15	1.88	Satisfactory			
	Total	67	1.97	Satisfactory			
Laboratory Based Teaching Method	Teacher I	8	1.55	Seldom Practiced	1.133	.343	Accept H_0 (Not Significant)
	Teacher II	37	1.55	Seldom Practiced			

Teacher III	7	1.51	Seldom Practiced
Principal I–IV	15	1.46	Seldom Practiced
Total	67	1.53	Seldom Practiced

Table 15 shows the comparative analysis of the respondents' assessments of their pedagogical skills in laboratory-based instruction, grouped by their position (Teacher I, Teacher II, Teacher III, and Principal I–IV). The table includes three pedagogical components: Instructional Strategies, Classroom Management, and Laboratory-Based Teaching Methods. In Instructional Strategies, the mean ratings ranged from 1.48 (Teacher I – "Rarely Applied") to 1.61 (Teacher III – "Occasionally Applied"), with an overall mean of 1.59 interpreted as "Rarely Applied." The ANOVA test produced an F-value of 0.926 and a significance level of 0.434, indicating no significant difference. For Classroom Management, mean ratings ranged from 1.88 (Principal I–IV – "Satisfactory") to 2.05 (Teacher III – "Satisfactory"), with an overall mean of 1.97, all interpreted uniformly as "Satisfactory." The F-value was 1.314 with a p-value of 0.278, again indicating no significant difference. Finally, in the Laboratory-Based Teaching Method, all groups had ratings between 1.46 (Principal I–IV) and 1.55 (Teacher I and II), with an overall mean of 1.53 — all falling under the "Seldom Practiced" category. The F-value was 1.133, and the significance was 0.343, which means there is no statistically significant difference across the positions.

The statistics illustrate the research participants' professional position demographics in relation to the pedagogical skills in laboratory-based instruction. Notably, Instructional Strategies were used "Rarely Applied" to "Occasionally Applied" across positions, suggesting infrequent application, especially among Teacher I (mean = 1.48). For Classroom Management, all groups rated themselves "Satisfactory," with minimal variance, suggesting a consistently developed skill across roles. Laboratory-Based Teaching Method was rated as "Seldom Practiced" across all positions, with even Principals (mean = 1.46) showing low engagement in such methods. Importantly, all three areas yielded non-significant p-values ($p > 0.05$) in the ANOVA test, supporting the conclusion that position does not significantly affect the level of perceived pedagogical skill in these domains.

The absence of statistically significant differences (p-values: 0.434, 0.278, and 0.343) across all three pedagogical areas indicates that position or professional rank does not influence self-assessed pedagogical competence in laboratory-based instruction. This uniformity may point to common training experiences, standardized expectations, or shared resource limitations across the institution. Particularly concerning is the low frequency of Laboratory-Based Teaching Methods ("Seldom Practiced" used across all positions), which may reflect systemic challenges such as insufficient laboratory facilities, lack of instructional materials, or limited training on practical science pedagogy. Meanwhile, the "Satisfactory" rating in Classroom Management may suggest that this skill is more universally developed, possibly through experience, peer learning, or mentorship. Overall, these findings highlight the need for capacity-building efforts, especially in laboratory instruction, that cut across all hierarchical levels. The lack of significant differences suggests that professional development efforts and institutional support in the Balicuatro Area have effectively leveled pedagogical competencies, ensuring that even novice teachers demonstrate comparable proficiency to their more experienced peers. The results underscore the critical role of structured training, peer collaboration, and access to teaching resources in achieving instructional equity, irrespective of teaching position.

Table 16

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal
of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 1 Issue 7 (2025)

Comparative Analysis of Assessment on the Respondents Level of Pedagogical Skills in Laboratory Based Instructions when Grouped According to Years of Teaching

ANOVA							
Pedagogical Skills	**Years of Teaching**	**N**	**Mean**	**Interpretation**	**F**	**Sig**	**Decision**
Instructional Strategies	Less than 1	4	1.45	Rarely Applied	.744	.530	Accept H_0 (Not Significant)
	1–3	30	1.60	Occasionally Applied			
	4-5	18	1.60	Occasionally Applied			
	7 above	15	1.60	Occasionally Applied			
	Total	67	1.59	Rarely Applied			
Classroom Management	Less than 1	4	2.02	Satisfactory	1.022	.389	Accept H_0 (Not Significant)
	1–3	30	2.01	Satisfactory			
	4-5	18	1.97	Satisfactory			
	7 above	15	1.88	Satisfactory			
	Total	67	1.97	Satisfactory			
Laboratory Based Teaching Method	Less than 1	4	1.55	Seldom Practiced	1.060	.372	Accept H_0 (Not Significant)
	1–3	30	1.56	Seldom Practiced			
	4-5	18	1.54	Seldom Practiced			
	7 above	15	1.46	Seldom Practiced			
	Total	67	1.53	Seldom Practiced			

Table 16 presents a comparative analysis of the respondents' pedagogical skills in laboratory-based instruction, categorized by their length of teaching experience in Senior High Schools within the Balicuatro Area, Division of Northern Samar. The data spans three core domains: Instructional Strategies, Classroom Management, and Laboratory-Based Teaching Methods.

In regard to the Instructional Strategies, all cohorts with more than one year of experience had identical mean ratings of 1.60, categorized as "Occasionally Applied". The lone respondent tenured with less than a year of experience recorded a slightly lower mean of 1.45, falling under "Rarely Applied". Despite this slight variation, the ANOVA result ($F = 0.744$, $p = 0.530$) shows no statistically significant difference among groups, indicating that teaching experience does not significantly influence the diversity of instructional strategies used in laboratory-based settings. This finding contrasts with earlier assertions (e.g., Darling-Hammond & Podolsky, 2019) that experience is a major determinant of instructional quality, possibly due to the uniform implementation of training programs in the division.

For Classroom Management, mean scores were consistently rated as Satisfactory across all experience groups, ranging from 1.88 to 2.02. Notably, teachers with 7 years or more experience showed slightly lower mean ratings (1.88), which might suggest a shift toward less traditional classroom control in favor of more student-centered approaches. However, the ANOVA result ($F = 1.022$, $p = 0.389$) again confirms no significant difference among groups. Affirming the concept that classroom management is a competency uniformly developed across experience levels, potentially due to mentorship and peer modeling.

In terms of Laboratory-Based Teaching Methods, mean scores declined slightly with increasing experience—from 1.56 (1–3 years) to 1.46 (7 years and above)—yet all fell within the category of "Seldom Practiced". While this trend hints at a possible deeper integration of practical work by more experienced teachers, the ANOVA result (F = 1.060, p = 0.372) implies that the differences are statistically insignificant. This finding echoes the conclusions of Tamayo and Alipio (2022), who emphasized the role of external factors—such as lab resource availability and curriculum limitations—rather than teaching tenure in determining the extent of laboratory integration.

The findings in Table 16 reveal that tenure of teaching careers does not significantly influence SHS-Science teachers' pedagogical skills in laboratory-based instruction across the areas of instructional strategies, classroom discipline aspects, and laboratory-based teaching methods. The lack of significant differences suggests that professional development efforts and institutional support in the Balicuatro Area have effectively leveled pedagogical competencies, ensuring that even novice teachers demonstrate comparable proficiency to their more experienced peers. Underscoring the critical role of structured training, peer collaboration, and access to teaching resources in achieving instructional equity, irrespective of teaching experience.

Problem No. 5 Is there a significant difference between the assessment of the respondents on the current status of science laboratory facilities and the respondents' level of pedagogical skills in laboratory-based instruction?

Table 17
Correlational Between the Assessment of the Respondents on the Current Status of Science Laboratory Facilities and the Respondents' Level of Pedagogical Skills in Laboratory-Based Instruction

PEARSON CORRELATIONS			
Laboratory Assessment	**Parameters**	**Value**	**Interpretation**
Adequacy	Pearson Correlation	0.265*	Reject Ho (Significant correlation)
	Sig. (2-tailed)	0.030	
	N	67	
Utilization and Engagement	Pearson Correlation	-0.079	Accept Ho (No significant correlation)
	Sig. (2-tailed)	0.523	
	N	67	
Safety and Standard	Pearson Correlation	0.002	Accept Ho (No significant correlation)
	Sig. (2-tailed)	0.989	
	N	67	

*Correlation is significant at the 0.050 level (2 tailed).

Table 19's Pearson correlational analysis demonstrates a significant positive relationship between the adequacy of laboratory infrastructure and the pedagogical skills of science teachers in the Balicuatro Area, Northern Samar Division (r = 0.265, p = 0.030). The finding of the study suggests that despite the challenges faced in this coastal and island municipality—characterized by limited infrastructure, scarce laboratory equipment, and logistical difficulties inherent in geographically isolated and resource-constrained areas—the perceived adequacy of available laboratory resources is vital in improving teachers' ability to effectively implement laboratory-based instructional strategies.

Adequate laboratory facilities provide the necessary support for teachers to actively involve the students in practical, hands-on learning tasks that are essential for deepening scientific understanding (Tytler et al., 2019). Conversely, the limited adequacy of laboratory facilities in Balicuatro is likely a significant contributing factor to the overall low levels of pedagogical skills observed among science teachers, as reflected by the positive but modest correlation between these variables. This situation is exacerbated by the unique challenges posed by the coastal and island geography of the Area, which restricts access to consistent supply chains, funding, and professional development opportunities (Nolasco et al., 2021).

Moreover, there was no notable statistical link discovered between utilization and engagement ($r = -0.079$, $p = 0.523$) or safety and standard protocols ($r = 0.002$, $p = 0.989$) and pedagogical skills, indicating that while these aspects are important for laboratory management and student welfare, they do not directly influence teachers' pedagogical proficiency within this context.

The findings of the study support earlier studies on the critical importance of standardized laboratory facilities in fostering effective science teaching and learning, particularly in under-resourced or geographically isolated settings (Jenkins et al., 2020; Loughran, 2022). Jenkins et al. (2020) emphasize that resource adequacy significantly impacts teachers' confidence and skills in employing diverse and inquiry-based instructional methods. Meanwhile, Loughran (2022) notes that infrastructural constraints in rural and island communities often hinder the implementation of optimal pedagogical practices.

Therefore, addressing the inadequacy of laboratory facilities in the Balicuatro Area should be prioritized to improve pedagogical skills among science teachers. Enhanced investment in laboratory infrastructure, consistent supply of materials, and targeted professional development tailored to the challenges of remote and coastal settings could provide the foundation necessary for elevating science education quality in the region.

These results point to a clear need in the Balicuatro Area, Northern Samar Division, for long-term solutions aimed at improving science education in remote communities. Without access to proper laboratory facilities, even skilled and motivated teachers may struggle to create meaningful, hands-on learning experiences. This limitation can affect not just how science is taught but also how well students grasp key scientific concepts that are vital for their academic formation and career path in the future.

Problem No. 6 Based on the research findings, what action plan may be recommended?

Action Plan on Strengthening Pedagogical Skills Through Laboratory-Based Instruction and Enhancement of Science Laboratory Facilities in Public Senior High Schools (Balicuatro Area, Northern Samar Division).

Rationale:

The study revealed that while Senior High School science teachers in the Balicuatro Area exhibit low to moderate pedagogical competence, the inadequacy of laboratory facilities—especially in rural and coastal municipalities—continues to hinder optimal science instruction. The results emphasized a strong correlation between highly adequate, safe, and utilized laboratory environments and improved instructional

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Volume 1 Issue 7 (2025)

strategies, classroom engagement, and hands-on learning. Thus, this action plan is proposed to address facility deficits, enhance teacher capacities, and foster a culture of practical, inquiry-based learning in public SHSs across the region.

General Goal:
To improve science education delivery through enhanced pedagogical practices and the provision of functional, safe, and engaging science laboratory environments.

Objectives:
1. To train at least 75% of SHS science teachers and School Heads in Balicuatro Area, Division of Northern Samar, in laboratory-based instruction within SY 2025–2026.
2. To ensure 80% of public SHS in rural and coastal municipalities in the Balicuatro Area (San Isidro, Victoria, San Antonio, Capul, San Vicente, Allen, Lavezares and Biri), Division of Northern Samar meet basic adequacy and safety standards in their laboratory facilities.
3. To increase laboratory utilization by requiring at least one lab-based activity per month in 70% of SHS science classes.

Area of Concern	Objectives	Activity/ Strategy	Persons Involved	Budget	Budget Source	Success Indicator
Teacher Pedagogical Skills	Train at least 75% of SHS science teachers by SY 2025–2026	Division-wide INSET/workshops on laboratory instruction and assessment integration	Division EPS, School Heads, Science Teachers, Local HEI Experts	₱15,000	SEF, MOOE	30 out of 40 teachers show improved post-training assessments
Laboratory Equipment & Facilities	Equip 80% of public SHSs in rural/coastal areas	Conduct inventory and procure basic lab starter kits aligned to MELCs	School Heads, Science Coordinators, LGUs, DepEd Division	₱50,000	SEF, LGU, DepEd RO VIII	8 out of 10 schools reach 80% equipment adequacy
Laboratory Safety Standards	Ensure 100% compliance with lab safety standards	Install signage, provide PPE, first aid kits, and conduct lab safety drills	DRRM Coordinators, Science Teachers, Brgy. Health Workers	₱1,000	MOOE, LGU Brgy. Fund	All 10 SHSs conduct annual lab drills and submit compliance reports
Lab Utilization &	Ensure 70% of SHS classes	Integrate lab tasks in lesson plans	Science Teachers, Dept.	₱1,000	MOOE, PTA	28 of 40 teachers submit lab

Student Engagement	conduct monthly lab activities	and quarterly reports	Heads, Students			activity logs with student outputs
Infrastructure Development	Build one standard SHS lab in each of the 8 municipalities by 2027	Lobby for inclusion in AIPs, and LGU and national budget proposals	SDS, School Heads, Mayors, LPDCs, Congressmen	₱50,000	LGU IRA, DPWH, Congressional Funds	8 municipalities pass resolutions or fund allocations
Stakeholder Partnership	Formalize 5 resource partnerships	Launch "Adopt-a-Lab" with alumni, NGOs, business sector	School Heads, GPTA, NGOs, Alumni	₱1,000	NGOs, GPTA	5 signed MOAs with stakeholders by SY 2025–2026

4. Discussion

- Interpretation of findings

The findings of respondents' age distribution, which included Senior High School science teachers and school administrators from public schools within the Balicuatro Area of the Northern Samar Division, reveal that the largest proportion (32.8%) falls within the 31–40 age bracket, followed by individuals aged 51 and above (26.9%), those between 41 and 50 years old (20.9%), and the youngest group, aged 21–30 (19.4%). This demographic trend suggests a predominantly mid-career teaching cohort, which plays a pivotal role in advancing science education. Their experience and professional maturity are particularly significant in promoting and sustaining laboratory-based instructional innovations across the municipalities of Allen, Lavezares, Biri, San Isidro, Capul, San Antonio, San Vicente, and Victoria. In terms of sex, it is dominated by females with 70.1% of the total population size; on the other hand, male respondents constituted 28.4%, and 1.5% preferred not to disclose their gender. The results indicate a female-dominated teaching force in science education across public Senior High Schools in the Balicuatro Area. From the perspective of civil status, most of the respondents were married, representing 64.2% of the total population. Single teachers comprised 25.4%, while widowed respondents made up 10.4%. This finding suggests a relatively stable professional population, possibly contributing to consistent instructional delivery in science subjects. Regarding professional positions, the largest group was Teacher II, with 55.2%, followed by Principals (Principal I–IV) at 22.4%, Teacher I at 11.9%, and Teacher III at 10.4%. This distribution reflects a strong presence of experienced instructional personnel in the public Senior High Schools in the Balicuatro Area. In relation to the teaching experience, 42.9% of respondents had been teaching for 1–3 years, 26.9% for 4–5 years, 22.4% for 6–7 years and above, and 5.7% had less than 1 year of experience. This statistical outcome indicates that while a number of teachers are relatively new, there is also a significant portion with mid- to long-term teaching experience in the region's public SHS science classrooms.

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Volume 1 Issue 7 (2025)

The findings revealed a general mean of 1.59, interpreted as "Rarely Applied". Suggesting that science teachers in the Balicuatro Area predominantly rely on traditional teaching strategies, with minimal variation or student-centered approaches, especially in the context of laboratory-based instruction. In terms of classroom management, the general mean was 1.97, which falls under the "Satisfactory" level. Indicating that while teachers manage classroom routines reasonably well, there is still room to enhance structure, engagement, and organization, especially during hands-on or inquiry-based activities. The general mean was 1.53, interpreted as "Seldom Practiced". This result reflects the limited use of actual laboratory activities in science instruction, with most respondents implementing very few or no practical experiments, possibly due to resource limitations in the schools.

The general mean for adequacy was 1.57, interpreted as "Not Adequate". The data reveals that some basic laboratory tools and resources exist in the Balicuatro Area, Division of Northern Samar, but they are generally insufficient for the effective delivery of hands-on science instruction. The findings in utilization and engagement showed a general mean of 1.47, falling under the interpretation of "Limited", which means that existing laboratory resources in the Balicuatro Area, Division of Northern Samar, are seldom used in instruction, likely due to either lack of training, time, or full equipment. In terms of safety and standards, the general mean was 1.48, which is interpreted as "Rarely Practiced", which implies that most science laboratories in the Balicuatro Area, Division of Northern Samar, do not meet standard safety protocols and may lack proper facilities such as ventilation, safety signages, or personal protective equipment (PPE) and equipment on fire safety.

In regard to the quantitative assessment of age and pedagogical skills in three domains, the instructional strategies (p= 0.809), classroom management (p=0.63) and laboratory teaching methods (p= 148), statistical analysis reflected no important statistical relationship in the pedagogical skills of SHS-Science teachers and school heads when grouped according to age. Further, illustrates that the research participants across all age groups in the Balicuatro Area, Northern Samar Division, exhibited comparable levels of laboratory-based instructional practice.When it comes to the quantitative analysis of pedagogical skills across the three domains namely instructional strategies (p=0.434), classroom management (p=402) and laboratory-based teaching methods (p=0.911) to sex, statistical findings exhibit no significant difference between pedagogical skills of the SHS-Science teachers and heads of school when grouped based on respondents' sex demographics, suggesting that both male and female respondents in Balicuatro Area, Northern Samar Division, shared parallel instructional approaches in laboratory-based teaching. With a significance level of p = 0.629 in instructional strategies, p = 0.209 in classroom management and p = 0.674, civil status also did not result in a significant difference in pedagogical skills of the SHS-Science teachers and school heads in Balicuatro Area, Northern Samar Division. Further, this entails that whether single, married, or widowed, respondents demonstrated relatively similar teaching practices. The data revealed no significant difference in pedagogical skills based on the respondents' professional position (instructional strategies p = 0.434, classroom management p = 0.278, laboratory-based teaching methods p = 0.343), indicating that whether one is a classroom teacher or a school head in the Balicuatro Area, Division of Northern Samar, their level of laboratory-based pedagogical skill did not differ substantially. Lastly, there was no significant difference throughout the pedagogical skills, specifically instructional strategies (p = 0.530), classroom management (p = 0. 389), and laboratory-based teaching methods (p = 0.372) when respondents were grouped by years of teaching experience. This finding implies that teaching tenure did not strongly influence the application of laboratory-based instruction in the Balicuatro Area, Division of Northern Samar.

The study with the Public SHS-Science teachers and heads of schools in Balicuatro Area, Northern Samar Division, found a significant relationship between the adequacy of science

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https://journals.aloysianpublications.com
Volume 1 Issue 7 (2025)

laboratory facilities and the level of pedagogical skills of teachers and school heads (Pearson r = 0.265, p = 0.030). Suggesting that well-equipped laboratories are associated with improved teaching strategies and greater integration of laboratory-based learning. Conversely, inadequately equipped laboratories tend to limit the application of effective, hands-on instructional methods. However, no significant relationship was found between pedagogical skills and the dimensions of utilization and engagement (r = -0.079, p = 0.523) and safety and standards (r = 0.002, p = 0.989). Reveals that the mere presence of laboratories in Balicuatro Area, Division of Northern Samar, if they are underutilized or fail to meet safety standards, does not necessarily enhance pedagogical practices. In essence, it is the adequacy of resources, rather than their presence or usage, that most significantly influences the effectiveness of laboratory-based instruction.

An action plan is recommended to address the identified gaps. First, procurement of essential laboratory equipment and upgrading of facilities should be prioritized to improve adequacy. Second, regular capacity-building training programs should be conducted to enhance science teachers' competencies in laboratory-based instruction. Third, contextualized lesson integration of laboratory activities should be implemented to encourage consistent utilization of resources. Fourth, schools must ensure compliance with safety standards, including the installation of safety signs, provision of PPE, and implementation of emergency procedures. Finally, monitoring and evaluation mechanisms should be established to assess the progress and impact of laboratory-based instruction on teaching practices in the public Senior High Schools of the Balicuatro Area.

- Comparison to existing studies

Aspect	Existing Study (Doncillo, 2025)	Related Studies
Setting	Rural public senior high schools in Balicuatro Area, Division of Northern Samar	Mostly urban or national-level contexts (e.g., Garcia & Lee, 2023; Freeman et al., 2023)
Focus	Correlating science lab adequacy, use, and safety with SHS teachers' pedagogical skills	Examining effects of lab access on student performance, teacher practices, and science engagement
Pedagogical Framework	Emphasized **instructional strategies, classroom management**, and **lab-based methods**	Supported by **inquiry-based learning (IBL), project-based learning (PBL), and experiential learning** (Clark et al., 2021; Dewey, 2020)
Findings on Lab Adequacy	Moderately adequate; only adequacy correlated significantly with pedagogical skills	Garcia & Lee (2023): Lab adequacy directly improves abstract learning, creativity, and retention
Findings on Lab Use and Safety	No significant correlation with pedagogical skills	Wilson (2020), Fernandez & Lopez (2022): Lack of use and unsafe conditions reduce student motivation and accuracy
Technology Integration	Not commonly practiced due to infrastructure limitations	Krajcik & Blumenfeld (2020): Virtual labs and simulations used to supplement learning in resource-poor areas
Teacher Factors	Many mid-career educators, lacking lab training	Anderson & Kim (2021): Teacher training key to maximizing lab use; Green et al. (2020): Emphasize regular upskilling

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Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 1 Issue 7 (2025)

Aspect	Existing Study (Doncillo, 2025)	Related Studies
Equity and Accessibility	Study addressed underserved, geographically isolated communities	UNESCO (2021): Emphasizes global disparity in lab access; promotes educational equity through facility investment
Research Gap Addressed	First to provide correlational data between lab facilities and pedagogical skills in Northern Samar	Most studies focused on student outcomes or national-level policies; few targeted rural Philippine contexts

- Implications for practice and policy

Implications and Policy Recommendations

Implications

1. **Science Laboratory Infrastructure Matters—but It's Not Enough Alone**
   The study revealed that only the *adequacy* of laboratory facilities has a significant relationship with teachers' pedagogical skills, while *utilization* and *safety* did not. This suggests that merely having lab facilities does not automatically lead to improved instruction—**training, consistent use, and safety compliance** are equally crucial.
2. **Teacher Capability Must Go Hand in Hand with Facility Improvement**
   Many educators in the Balicuatro Area are in their early to mid-career stages, indicating an ideal window for **professional development**. However, the lack of access to standard laboratory facilities hampers their growth in laboratory-based instruction. Therefore, infrastructure development must be complemented with **teacher support and capacity-building programs**.
3. **Underserved Rural Areas Require Targeted Interventions**
   The geographic isolation and limited funding of rural schools in Northern Samar result in science laboratories that are either outdated, underused, or unsafe. This highlights the need for **context-sensitive education policies** that prioritize rural science education equity.
4. **Policy Support Needed to Bridge Rural–Urban Education Gap**
   The disparity in science performance between rural and urban areas, as demonstrated by national test scores, points to a broader issue of **resource distribution and curriculum implementation support**.

Policy Recommendations

1. **Mandatory Laboratory Improvement Program for Rural SHS**
   The Department of Education (DepEd), in partnership with LGUs, should institutionalize a **Science Laboratory Modernization Program** specifically for rural Senior High Schools. This policy should include annual auditing, facility upgrading, and provision of minimum lab equipment standards aligned with the K to 12 curriculum.
2. **Teacher Training Mandate on Laboratory-Based Instruction**
   Implement a **required laboratory pedagogical training module** for all SHS science teachers,

especially those in underserved regions. This training should include experiential learning strategies, safety protocols, and resourcefulness in low-resource settings.

3. **Incentive-Based Laboratory Utilization Reporting**
Introduce a **School-Based Incentive System** that rewards schools and teachers for documented and innovative use of laboratory facilities. This includes recognition in performance-based bonuses or school grants.
4. **Local Government Science Education Fund**
Encourage LGUs to allocate a **Science Education Development Fund (SEDF)** dedicated to constructing and maintaining science laboratories and funding science equipment purchases.
5. **Regular Compliance Monitoring on Lab Safety Standards**
Strengthen the DepEd's **Compliance and Inspection Program** to ensure that laboratory facilities meet basic safety standards. Include school heads in accountability measures through performance reviews.
6. **Integration of Virtual Labs in Curriculum Policy**
For schools with persistent physical limitations, DepEd should endorse the use of **virtual labs and simulations** as a formal part of the science curriculum and provide digital tools accordingly.

- Study limitations

This study wanted to examine the role of science laboratory facilities in pedagogical skills through laboratory-based instruction and its relation to the current status of the science laboratory facilities in public senior high schools in the Balicuatro Area, Northern Samar Division. Particularly, it aimed to determine the adequacy of science laboratories, utilization and engagement, the safety and standard of laboratory infrastructure and its impact on instructional strategies, classroom management, and laboratory-based teaching methods.

The study was limited to public Senior High Schools within the Balicuatro Area, Northern Samar Division, covering the towns of Allen, Lavezares, Biri, Victoria, Capul, San Antonio, San Vicente, and San Isidro. All respondents in this research were SHS-science teachers and heads of schools in these areas, using a complete enumeration sampling method.

This research does not extend to private schools or junior high school levels. It does not assess student performance outcomes but rather focuses on how laboratory facilities influence teachers' instructional approaches. A correlational research approach was used in this study. It utilized surveys and statistical tools such as chi-square tests, ANOVA, and Pearson or Spearman correlation to analyze the data.

5. Conclusion

This study explored the pedagogical skills of SHS-Science teachers and heads of schools regarding the condition of science laboratory facilities in public schools within the Balicuatro Area, Division of Northern Samar. The findings highlighted critical gaps in both instructional practices and facility provision that directly affect the quality of science education in the region.

1. The demographic statistics of SHS-Science teachers and school administrators in the Balicuatro Area, Northern Samar Division, highlight a predominantly mid-career and professionally stable workforce. The majority fall within the 31–40 age group, suggesting a cohort that brings both vitality and valuable

experience to science education. The significant presence of teachers aged 51 and above further enriches the educational landscape with their seasoned expertise, particularly in implementing laboratory-based instructional strategies across the eight municipalities. The findings also reveal a female-dominated teaching force, with over 70% of respondents identifying as female, aligning with broader national trends in the education sector. The high proportion of married individuals points to a potentially stable and committed teaching population, which may positively influence the consistency and quality of science instruction. Professionally, the dominance of Teacher II positions, along with a notable number of Principals and other teacher ranks, reflects a strong representation of experienced and leadership-oriented personnel. This professional structure supports the sustained advancement of science education initiatives and instructional innovations in the region's public schools. Overall, these demographic trends underscore the capacity and readiness of the teaching and administrative workforce to drive science education forward in the Balicuatro Area.

2. The analysis suggests that science instruction in the Balicuatro Area largely adheres to conventional teaching models, with limited incorporation of interactive or student-directed strategies, particularly in laboratory-based contexts. Classroom management practices, while generally acceptable, indicate the potential for refinement to foster a more structured and engaging environment suited to practical and inquiry-driven learning. Furthermore, the infrequent use of hands-on scientific activities underscores persistent challenges—such as possible resource limitations—that may be inhibiting the full integration of experiential learning in science education. The Pedagogical skills of SHS-Science teachers and heads of schools in the Ballicuatro Area reveal that in the domain of instructional strategies, classroom management, and laboratory-based teaching methods were found to be generally below the acceptable parameters. Science instruction was kept largely theoretical, and laboratory-based instruction was occasionally integrated into classroom practice. SHS-Science teachers and school heads frequently used traditional methods, with little emphasis on hands-on laboratory activities and inquiry, which are vital to developing scientific thinking and problem-solving skills among students.

3. The current situation of science laboratory facilities in the schools studied was also determined to be inadequate. Most laboratories were lacking sufficient equipment, were underutilized, and did not meet safety standards. These issues particularly manifest in remote and island municipalities within the Balicuatro Area, where logistical and financial constraints further limit access to functional and safe laboratory environments. The outcome of these is that science instruction in many schools is restricted not only by science teaching capability but also by the physical aspects of the learning environment.

4. In light of the findings, it can be concluded that there are no significant statistical correlations between the demographic profiles and the level of pedagogical skill in laboratory-based science instruction of the respondents across the different fields such as instructional strategies, classroom management and laboratory-based teaching methods within the Balicuatro Area, Northern Samar Division. Across variables including age, sex, civil status, professional position, and years of teaching experience, respondents demonstrated generally consistent approaches to laboratory instruction. These results suggest that instructional practices related to laboratory use are not markedly influenced by personal or professional background, indicating a level of uniformity in pedagogical engagement across the respondent pool. This consistency may reflect shared training backgrounds, institutional expectations, or resource limitations that shape teaching strategies regardless of individual differences.

5. The results demonstrate a remarkable connection between the adequacy of laboratory infrastructure and pedagogical approaches employed by Senior High School science educators and school leaders in the Balicuatro Area, Division of Northern Samar. Specifically, better-equipped laboratories support more effective and skillful integration of hands-on instructional strategies. In contrast, the quality of teaching

was not notably influenced by either the frequency of laboratory use or adherence to safety protocols, suggesting that access to sufficient and functional equipment carries greater weight than mere presence or regulatory compliance. These results affirm the critical role that resource adequacy plays in shaping effective laboratory-based instruction, and they reinforce the importance of targeted investments in both physical facilities and professional development efforts to improve science teaching across the region.

6. In conclusion, the study underscores the critical need to strengthen laboratory-based science instruction in the Public-SHS in Balicuatro Area, Northern Samar Division. The proposed action plan offers a strategic pathway for addressing the identified gaps in adequacy, utilization, teacher preparedness, safety compliance, and instructional consistency. By prioritizing the enhancement of laboratory resources, investing in teacher training, integrating practical activities into the curriculum, and upholding safety standards, schools can develop impactful and student-centered science educational settings. Establishing mechanisms for regular monitoring and evaluation will further support the sustained improvement of pedagogical practices, ensuring that laboratory instruction becomes a meaningful and reliable component of science education in the region.

Recommendations

Public Senior High Schools in the Balicuatro Area, Division of Northern Samar, evidently showed a lack of adequate science laboratory facilities and low levels of pedagogical skills in laboratory-based instruction. These findings reveal a critical need for structural improvements and targeted capacity-building efforts to strengthen the quality of science education in the region. The researcher, therefore, recommends the following strategies:

1. Given the solid professional background and demographic consistency of Senior High School science educators and administrators in the Balicuatro Area, it is recommended that these human capital strengths be strategically leveraged to further enhance science education in the region. Professional development programs should be tailored to match the needs of both mid-career and veteran teachers, fostering mentorship opportunities that allow more experienced educators to guide their younger counterparts in implementing laboratory-based teaching strategies. Additionally, recognizing the high representation of female and married teachers, school leaders may explore initiatives that support work-life balance and long-term retention, contributing to sustained instructional continuity. Lastly, the presence of leaders across teaching and administrative roles provides a valuable foundation for shared decision-making and collaborative planning, which can strengthen the implementation of curriculum innovations and capacity-building initiatives throughout the division.

2. In response to the statistical result, it is recommended that sustained professional development efforts be initiated to improve the pedagogical skills of SHS-Science teachers and heads of schools in the Balicuatro Area. Specifically, there is a pressing need to shift from predominantly theoretical instruction to more practical, inquiry-based learning. That can be achieved by institutionalizing Learning Action Cell (LAC) sessions focused on laboratory facilitation techniques, active classroom strategies, and student-centered approaches. In addition, enhanced In-Service Training (INSET) programs should be delivered regularly to equip educators with the necessary tools and confidence to manage and integrate laboratory-based methods effectively. Encouraging contextualized lesson planning that makes use of locally available materials can help sustain hands-on activities despite resource constraints. Moreover, schools may promote peer mentoring systems

to encourage collaboration and skills-sharing among teachers. By embedding these strategies into the school culture, science instruction in the region can evolve into a more dynamic, engaging, and skill-enhancing experience for students.

3. Based on the respondents' assessment, the overall condition of science laboratory infrastructures in Public-SHS across the Balicuatro Area remains a significant concern. The findings point to widespread inadequacy in laboratory resources, limited use of existing facilities, and a general lack of compliance with safety protocols. These challenges are particularly pronounced in geographically isolated municipalities, where resource allocation and infrastructure development face added obstacles. As a result, science instruction is hindered not only by gaps in pedagogical practice but also by the constraints imposed by the physical learning environment. These conditions underscore the importance of addressing both material deficiencies and logistical barriers to ensure that laboratory-based learning becomes an accessible and effective component of science education in the region. School heads and science department leaders may institutionalize the integration of laboratory activities into regular classroom instruction, including creating structured schedules for laboratory use, embedding practical work in lesson plans, and developing localized experiment guides that suit available resources. Classroom observations and performance evaluations should also emphasize the use of laboratory-based strategies as a key teaching competency.

4. The outcomes indicate that the pedagogical skills of SHS-Science teachers and heads of schools in the Balicuatro Area show no meaningful variation when grouped according to demographic factors such as age, sex, civil status, position, or teaching tenure. Regardless of these individual characteristics, respondents appeared to demonstrate similar patterns in the delivery of laboratory-based instruction. Suggesting that instructional practices in the region may be shaped more by common institutional conditions, collective training experiences, or uniform resource limitations than by personal background. The results highlight a consistent instructional approach across different educator profiles, pointing to a shared set of teaching norms or systemic constraints within the public school setting.

5. Based on the findings, it is recommended that science education stakeholders in the Balicuatro Area prioritize investments in the adequacy of laboratory resources, recognizing that well-equipped facilities play a pivotal role in enhancing laboratory-based instruction. Efforts should focus not merely on providing laboratories but on ensuring that they are sufficiently stocked with functional, relevant, and curriculum-aligned equipment. Alongside infrastructure improvement, support for science educators through sustained capacity-building programs is essential—equipping them with the skills to effectively utilize these tools for interactive, hands-on learning. By aligning facility enhancement with professional development, schools can create a learning environment where pedagogical competence and practical science instruction grow in tandem, leading to deeper student engagement and improved learning outcomes. Further, the Division Office, through the Curriculum Implementation Division, should establish a technical monitoring and support team to assess laboratory conditions regularly, provide coaching, and assist schools in planning and implementing laboratory-related improvements. This team will be headed by the Education Program Supervisor in Science, and District supervisors should track the impact of facility upgrades and teacher training on instructional outcomes and student performance in science.

6. Based on the study's conclusion, it is recommended that schools in the Balicuatro Area prioritize a comprehensive improvement plan to enhance laboratory-based science instruction, which includes the procurement of adequate and curriculum-aligned laboratory equipment, as well as the upgrading of existing facilities to meet both instructional and safety requirements. To strengthen teacher

preparedness, regular training sessions—through Learning Action Cell (LAC) activities, In-Service Training (INSET), and practical workshops—should be conducted to build capacity in planning and delivering hands-on science lessons. Integrating laboratory activities into daily instruction should be encouraged, ensuring that practical learning becomes an essential part of teaching practice rather than an occasional addition. Furthermore, schools must establish systematic monitoring and feedback mechanisms to evaluate progress and maintain consistency in implementation. By addressing both material and instructional components, science education in the region can evolve to better engage students and develop their scientific literacy through meaningful, experience-based learning. Further research will be conducted to explore other variables that may influence the effectiveness of laboratory-based science instruction, such as student learning outcomes, curriculum alignment, and budgetary allocation patterns. Future studies may also include longitudinal or comparative analyses across divisions to generate broader policy implications and contribute to national efforts to improve STEM education in underserved areas.

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