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Research Article

Development of a Training Program for Upskilling Science Teachers' Laboratory Competence

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ABSTRACT

Science education in the Philippines is presently alarming due to the low achievement rating in various international assessments. This problem is rooted in the low utilization of laboratory-based instruction due to inadequate laboratory facilities and equipment. Hence, a descriptive-correlational research approach was conducted to determine the knowledge and skill competence of public-school teachers. Using a researcher-made survey questionnaire, it was revealed that the respondents have very high knowledge and skill competence when it comes to laboratory instruction with a mean score of 4.08 apiece. Meanwhile, an R-value of 0.9121 was computed showing a positive relationship between knowledge and skill competence. The result shows that teachers are competent enough to perform lab-based activities; however, there is a need for them to undergo training and seminars due to the low utilization of lab activities. From here, a training program dubbed as SCILAW was formulated. Through this, teachers will be able to hone their knowledge and skills in using lab-based teaching approaches.

Keywords: *Knowledge competence, Laboratory-based instruction, Science, Science teachers, Skill competence, Training program*

Introduction

Science education aims to develop students who are scientifically literate and able to understand the complexity of the scientific world. It underscores how the members of the society would be able to turn abstract knowledge into concrete applications of the concepts they have learned from their rigorous schooling. To ensure that the abstractness of science is lessened, teachers utilize laboratory-based instructions to ensure that everyone can grasp the idea being taught. Luftia, Wilujeng, and Zakwandi (2024) emphasize that laboratory activities foster critical thinking and problem-

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solving skills, which are essential components of scientific literacy. Practical experiments allow students to connect theoretical knowledge with real-world applications, thereby increasing their interest and comprehension of scientific principles (Emyur & Cetin, 2024). Moreover, Karpudewan and Chong Keat (2017) asserted that science laboratory instruction develops a positive attitude of learners in scientific learning and discovery. Through science laboratory activities, they are given the freedom to learn and develop the skills they need.

However, while it is true that science laboratories serve as a nest to develop the scientific skills of learners, it is also vital thing to consider the ability and competence of teachers in delivering quality scientific instruction. Competence in teaching science does not only revolve around cascading information and knowledge conceptually, but it is also necessary that science teachers have in-depth knowledge, understanding, and skills in providing enough aligned scientific activities to their learners. Their competence in using the laboratory apparatus, creating laboratory activities, supervising activities, and even enforcing rules and regulations inside a laboratory speaks volumes about their overall standing and skills in delivering quality laboratory instruction. In a study conducted by Shambare and Jita (2024) shed light on the status of science teachers' integration of technologies in teaching. It was revealed that they have a positive attitude toward using technologies; however, they lagged low proficiency level when it comes to utilizing such technologies.

As of writing, science education in the Philippines is in a great perilous situation in connection with the 2018 and 2022 Programme International Students Assessment (PISA). It was revealed that Filipino youth aged 15 find it difficult to comprehend scientific concepts. Likewise, in a parallel assessment in Trends in International Mathematics and Science Studies (TIMSS), the country was also placed somewhere down the bottom. These placements in international assessments reveal the loophole in the framework of science education.

This educational problem entails a negative drawback to the country's educational paradigm. In 2019, Zuhaida and Imaduddin revealed that 60% of the prospective science teachers have low laboratory literacy, which significantly suggests that they need improvement. In a separate study, it was revealed that junior high school teachers in Palu City, Indonesia rarely conduct science laboratory activities. Though it was stated in the paper that teachers are competent in delivering science laboratory instruction to students (Supriyatman, et al., 2024). However, the lack of teaching practice through the use of science laboratories took its roots from the inadequate number of facilities and equipment to be used by these teachers.

This research study was conducted to investigate on the status of science teachers' knowledge and skill competence. The result was used to develop a training matrix designed to help teachers gain enough knowledge and skills that they can use in teaching science concepts through the use of laboratory-based approaches.

Research Questions

This study aimed to determine science teachers' level of knowledge and skills in using laboratory-based instruction. Moreover, it also sought to develop a training framework to help teachers enhance their knowledge and skills in using laboratory.

Specifically, it sought answers to the following questions:

1. How is science teachers' level of knowledge in using laboratory-based instruction?
2. How is science teachers' level of skills in using laboratory-based instruction?
3. Is there a significant relationship between science teachers' level og knowledge and skills?
4. What training program can be developed?

Methods

Research Design

The researcher used a descriptive-correlational approach to determine the relationship between science teachers' level of knowledge and skill competence in using laboratory instruction. Descriptive research is used to shed light on the influencing factors related to a sce-

nario. Through the use of survey study to understand the teachers' level of knowledge and skills in using laboratory-based instruction. Meanwhile, by using the correlational approach, the status of teachers' laboratory competence was identified and served as the basis for developing the training program matrix.

Population and Sampling Procedure

Purposively identified, the respondents of this study were the public secondary science teachers in the Schools Division of Ilocos Norte (SDOIN). A total of 198 respondents were determined from the total number of science teachers in the said division.

Research Instrument

A two-part survey questionnaire was used in gathering the needed data for this study. The first part solicited the demographic profile of the respondents as to their sex, teaching position, length of teaching service, highest degree earned, and specialization.

Meanwhile, part two was a five-point Likert scale which determined the level of knowledge and skill competence of teachers. The tool was adopted from the instrument used by Gecer and Zengin (2016). The instrument have undergone thorough validation process using to determine the relevance of the instrument in conformity with the research goals.

Data Gathering Procedures

Initially, an ethical clearance was secured from the University Research Ethics and Review Board (URERB) to ensure the validity of the study. Permission to conduct the study was also sought from the College Dean. Letters were also sent to the Schools Division Superintendent of SDOIN to request the participation of the teachers.

Upon the acceptance of the approval sheet, the gathering of data was administered through an online platform. The link was also sent via a chat group and published through Facebook.

Data Analysis

The data were tabulated, organized, analysed, and interpreted with the use of descriptive and inferential statistics such as frequency counts, percentages, mean, and Pearson-r correlation with a 0.01 level of significance.

Ethical Considerations

This study followed the research protocol prescribed by the URERB to ensure that no participant in the study was forced. It was ensured that their participation was voluntary and that no personal and private information would be discharged without their consent. Furthermore, no monetary or other means of compensation were given to the respondents.

Result and Discussion

Knowledge Competency of Teachers in Science Laboratory

Table 1 shows the ten criteria for identifying the knowledge competency of science teachers in a laboratory. It can be gleaned from the tabulated result that teachers agreed strongly in 3 out of the 10 statements. Specifically, teachers pointed out that they know the importance of laboratory methods in science teaching with a mean score of 4.53. They also highlighted that they are knowledgeable about laboratory safety rules and laboratory teaching methods and techniques with mean scores of 4.33 and 4.27, respectively. Despite having an overall mean of 4.08, it was revealed that teachers still lack basic knowledge about all the science laboratory equipment and facilities.

Table 1. Knowledge competency of teachers in science laboratory

Statements	Mean	Descriptive Interpretation
I know the importance of laboratory methods in science teaching.	4.53	Strongly Agree
I know the teaching methods and techniques that are used in laboratory studies.	4.27	Strongly Agree
I have all the knowledge to create a safe working environment in the laboratory.	3.98	Agree

Statements	Mean	Descriptive Interpretation
I know all the tools in the science lab.	3.50	Agree
I have knowledge related to simple maintenance equipment in the laboratory.	3.86	Agree
I know about measuring students' knowledge and skills related to laboratory work.	4.05	Agree
I know about measuring students' attitudes regarding their laboratory studies.	4.03	Agree
I know how to select the appropriate tools for a given experiment.	4.11	Agree
I know how to follow safety rules when using equipment.	4.33	Strongly Agree
I know how to interpret test results.	4.14	Agree
Weighted Mean	**4.08**	**Agree**

The results of this study conform with the findings of Zabala and Dayaganon (2022) indicating that science teachers have very high knowledge competence as perceived by their learners. Meanwhile, in a parallel study conducted by Nipales (2019), she posited that science teachers have very good knowledge of teaching science topics in the new curriculum. She even specified that teachers are knowledgeable in operating science facilities and equipment. However, it was also revealed that they should be given proper training in using advanced technological science apparatus.

Skills Competency of Teachers in Science Laboratory

The utilization of laboratory skills is necessary to concretize the abstract concepts taught in science education. Hence, it is critical that teachers also have the skills and not just the knowledge in using lab equipment and doing lab work.

It can be gleaned from Table 2 that teachers do agree that they possess significant laboratory skill competence. Particularly, they strongly agreed that they could create and maintain a safe working environment and strictly follow laboratory safety precautions, with 4.30 and 4.36 mean scores. This signifies that teachers have the skill to develop a conducive learning space where their learners will gain ample knowledge and grasp the concepts that they want to teach to their learners. On the contrary, it was revealed that teachers are not skilled enough to use all science laboratory tools. This problem could be rooted in the inadequate laboratory facilities and equipment. Had it been that schools were given enough funding to purchase the apparatus that they needed, teachers could have been able to venture and find time to study the usage of these laboratory equipment.

Various studies revealed that teachers' skill competence directly impacts the cognitive level of their learners. Nipales (2019) revealed that teachers have very good skill competence when it comes to teaching science concepts as well as using laboratory approaches. It was further highlighted that teachers are well-versed in using different laboratory methods. However, it was posited that they should be introduced to advanced technical skills and communicative skills. Meanwhile, the study conducted by Supriyatman et al. (2024) also shared that teacher demonstrated good competency in planning and implementing laboratory-based instruction. These findings refute the previous results of Copriady (2014) stating that teachers have moderate skill competence in using the laboratory.

Table 2. Skills competency of teachers in science laboratory

Statements	Mean	Descriptive Interpretation
I can use appropriate teaching methods and techniques in laboratory studies.	4.18	Agree

Statements	Mean	Descriptive Interpretation
I can create and maintain a safe working environment in the laboratory.	4.30	Strongly Agree
I can use all the tools in the science lab.	3.32	Somewhat Agree
I can execute simple laboratory equipment maintenance.	4.11	Agree
I can organize an effective teaching environment in the laboratory.	4.17	Agree
I can develop and use simple tools for laboratory work.	4.12	Agree
I follow safety rules when doing laboratory activities.	4.36	Strongly Agree
I can interpret test results.	4.15	Agree
I can combine experimental results with theoretical knowledge to achieve new results.	4.05	Agree
I can execute science skills well.	4.00	Agree
Weighted Mean	**4.08**	**Agree**

Teachers' Overall Competence in Science Laboratory

Table 3 talks about the relationship between the knowledge competence and skill competence of teachers in laboratory-based teaching instruction.

Table 3. Overall teaching competence of teachers in laboratory-based instruction

Competency	Mean	r-value	Interpretation
Knowledge	4.08	0.9121	strong positive
Skills	4.08		

Based on Table 3, there is a positive correlation between the knowledge and skills competence of public-school teachers in science laboratories. This significant relationship highlights that teachers should possess both competencies to ensure that they can teach scientific concepts very well to their learners. Furthermore, both competencies go hand in hand; hence, they should be enhanced to make sure that teachers will be developed professionally.

Findings imply that the knowledge level of teachers reflects on their teaching application. This only means that when a teacher utilizes laboratory instruction, the teacher demonstrates an understanding of the techniques in laboratory teaching and has enough knowledge to execute them. Meanwhile, teachers who seldom use laboratory instruction may have limited knowledge in performing laboratory experiments.

Hence, it only strengthens the findings of Supriyatman et al. (2024) on the competence level of science teachers in using laboratory-based instruction. It was concluded in their study that teachers at Palu have respectable skills and knowledge competence in using the laboratory. Additionally, another study in Nueva Ecija revealed that science teachers who are teaching K to 12 science classes were very competent already.

However, there are areas wherein teachers should invest more to train to upskill themselves on the current trends in science education. In a study conducted by Pareek (2019), some of the factors that delimit teachers in using laboratory instruction include limited resources, inadequate time, as well as few teachers training to strengthen teachers' competence level. Thus, there is a need for teacher training activities that will reinforce the capabilities of science teachers to utilize science laboratory-based instructions.

SCILAW Training Program

To fully equip teachers with the necessary knowledge and skill competencies, they should

be provided with rigorous and updated training and seminars to ensure that they are aware of the trends in science education. Using these training and seminars, they will have the chance to learn from experts and be able to craft different materials and activities that suit best the interests of their learners. Hence, a sample training matrix was developed concerning the findings of the study relating to the status quo of public school teachers' knowledge and skill competence.

Table 4. SCILAW training program matrix

SCILAW: Strengthening Competence in Integrating Laboratory-based Activities and Workshops		
Objectives:		
• Enhance teachers' understanding of laboratory-based instruction methods. • Improve proficiency in handling laboratory equipment and conducting experiments. • Promote effective strategies for integrating laboratory activities with curriculum standards. • Strengthen teachers' abilities to assess student performance in laboratory settings.		
Day	**Time**	**Activity**
Fundamental of Laboratory-based Instruction		
1	7:30-9:00	Registration and Welcome Session
	9:00-10:30	Session 1: Importance and Principles of Laboratory-based Instruction
	10:45-12:15	Session 2: Planning Effective Laboratory Activities
	1:00-3:00	Session 3: Laboratory Safety and Management
	3:00-5:00	Demonstration on Proper Handling of Equipment and Open Forum
Advance Laboratory Techniques		
2	8:00-10:00	Session 4: Traditional and Modern Laboratory Tools and Equipment
	10:15-12:00	Session 5: Conducting Inquiry-based Experiments
	1:00-3:00	Session 6: Troubleshooting Common Laboratory Issues
	3:00-5:00	Open Forum and Development of Inquiry-based Lesson
Integration and Assessment		
3	8:00-10:30	Session 7: Integrating Lab Work into Lesson Plans
	10:30-12:00	Session 8: Assessing Laboratory Skills and Outcomes
	1:00-4:00	Session 9: Demonstration, Microteaching, and Open Forum
	4:00-5:00	Closing Ceremony

The SCILAW Training Program aims to help science teachers become more equipped with the necessary skill sets and knowledge to utilize laboratory-based instruction. In the words of Spatz (2022), training and seminars play a crucial role in equipping educators with interdisciplinary teaching approaches that will enhance their instructional delivery. It ensures that they will have adept skills and abilities to explain and concretize the scientific concepts they are teaching. Additionally, Liu et al. (2021), highlighted that these activities will also yield positive effects not just for teachers but also for the achievement of better learning outcomes on the part of the students. Thus, using timely and relevant training and seminars where teachers will be immersed, they can maximally provide quality education for their clients.

Conclusion

This study was conducted to unveil the status quo of public secondary science teachers in terms of their knowledge and skill competence in using a laboratory-based teaching approach. It was revealed that they have high knowledge and skill competence when it comes to laboratory instruction. Additionally, there is a positive correlation between knowledge and skill competence. However, teachers need to attend training and seminars to equip them with laboratory-based instructional knowledge and

skills. Thus, a training program dubbed SCILAW: Strengthening Competence in Integrating Laboratory-based Activities and Workshops was formulated.

Furthermore, the study also shed light on the importance of redeveloping the curriculum and providing teachers with necessary professional development activities such as relevant training to ensure that they would be able to utilize laboratory instruction fully. A need for mentoring is also a considerable action. Likewise, purchasing an adequate number of materials and facilities for laboratories could also be a starting ground to intensify the foundation of science laboratory instruction.

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