INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2025, Vol. 6, No. 4, 2059 – 2069
http://dx.doi.org/10.11594/ijmaber.06.04.33

Research Article

Teachers' Profile, Knowledge Competence, and Skill Competence in Laboratory Instruction; Its Implications to Physics Teaching

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Article history:
Submission 03 March 2025
Revised 31 March 2025
Accepted 23 April 2025

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ABSTRACT

Effective science instruction requires more than just dispensing information and conceptual knowledge; science teachers also need to have in-depth knowledge, understanding, and abilities to give their students appropriate and pertinent scientific tasks. Despite the fact that teachers exhibit proficiency in laboratory instruction, more research is required to determine how this proficiency directly impacts student learning outcomes in lab environments. Hence, a descriptive-correlational research approach was conducted to determine the relationship between the profile of science teachers and their knowledge and skill competence in science laboratory instruction. Results revealed that gender (sex) has a negative correlation with both knowledge and skill competency. This indicates that male and female teachers may have different competency levels. Moreover, higher degrees and teachers' field of specialization contribute positively to both knowledge and skill competency in science laboratory instruction. However, teaching position and length of teaching have weak indicating that experience alone may not strongly influence knowledge and skill competence in science laboratory.

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

Background

Teaching science effectively involves more than just imparting conceptual knowledge and information; science instructors must also possess in-depth knowledge, comprehension, and abilities to provide their students with adequate and relevant scientific activities. Their total reputation and proficiency in providing high-quality laboratory education are fully demonstrated by their proficiency with the equipment, designing and directing laboratory activities, and even enforcing rules and regulations inside a laboratory.

Even though both teaching and laboratory proficiency are necessary for complete scientific laboratory education, science teachers still face challenges in delivering high-quality instruction. The main issue might be either

How to cite:
Atud, F. M. R., Cabrera, R. M., & Calzada, M. P. T. (2025). Teachers' Profile, Knowledge Competence, and Skill Competence in Laboratory Instruction; Its Implications to Physics Teaching. *International Journal of Multidisciplinary: Applied Business and Education Research*. *6*(4), 2059 – 2069. doi: 10.11594/ijmaber.06.04.33

teachers' inability to use laboratory education effectively or a lack of proper laboratory facilities and equipment. Regardless of the reason, the outcome will be students' poor understanding of scientific topics. This can be reflected from the very low ranking of the Philippines in international assessments such as the Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study where Filipino learners ranked 78 and bottom last, respectively (Magsambol, 2020).

The state of teachers' proficiency in teaching science through laboratory-based activities has been the subject of numerous research. According to Zuhaida and Imaduddin's (2019) study, 60% of aspiring science instructors lack laboratory literacy, which strongly implies that they require development. According to a different study, Junior High School teachers in Palu City, Indonesia, they seldom engage in science lab activities. Despite this, the article claimed that teachers are capable of providing students with science laboratory teaching (Supriyatman et al., 2024). However, the insufficient quantity of facilities and equipment available to these teachers was the primary cause of the lack of teaching practice through the utilization of science laboratories. To increase their laboratory teaching competence, teachers must engage in ongoing professional development. In addition, training should emphasize both pedagogical skills and subject matter knowledge to increase teachers' efficiency in the classroom (Qadeer et al., 2024).

Despite the fact that teachers exhibit proficiency in laboratory instruction, more research is required to determine how this proficiency directly impacts student learning outcomes in lab environments. This includes being aware of how student performance in science process skills and instructor competency are related. More work needs to be done on developing practicum guides and carrying out experiments. To enhance the quality of laboratory instruction, research might look into efficient methods for teachers to acquire these abilities (Supriyatman et al., 2024).

The effectiveness of physics teaching is significantly influenced by teachers' profiles, knowledge competence, and skill competence in laboratory instruction. These are crucial for implementing and evaluating laboratory-based learning, which in turn impacts student motivation and learning outcomes. According to Lehesvuori et al. (2023), one of the implications to Physics teaching is that learning and student engagement can be improved in laboratory sessions by implementing student-centered teaching. This entails engaging in interactive dialogue and tying students' experiences to the educational process. Moreover, enhancing teachers' proficiency in laboratory instruction requires ongoing professional development and training programs, which should concentrate on building both professional and personality abilities to prepare instructors for a variety of learning environments (Moreira et al., 2023).

With the aforementioned status above, the researcher is challenged to determine the laboratory competence of science teachers in terms of knowledge on science laboratory and skills in conducting science laboratory in the Schools Division of Ilocos Norte (SDOIN). Furthermore, it also identifies the possible implications of their knowledge and skill competence to Physics teaching.

Methods

Research Design

This study utilized the descriptive-correlational research design. It is descriptive because it aimed to determine the profile of physics teachers as well as their laboratory competence. It is correlational because it aimed to determine the relationship between the profile of physics teachers and their laboratory competence.

Population and Sampling

The purposive sampling method was used to gather the data from all Junior and Senior High School Science teachers who are currently teaching in the Schools Division of Ilocos Norte. Total enumeration was utilized in this study.

Research Instruments

This study utilized a survey questionnaire titled "Physics Teachers Laboratory Competence" adopted from the tool used by Gecer and Zengin (2016) and was validated by the thesis adviser and the members of the

panel. It sought to determine the competency level of teachers in terms of knowledge and skills in using and providing laboratory instruction. Aside from this, another tool to unravel teacher's extent on using laboratory instruction was also adopted from Gecer and Zengin (2016).

Data Gathering Procedures

To guarantee the study's validity, an ethical clearance was first obtained from the University Research Ethics and Review Board (URERB). Additionally, the College Dean was asked for permission to perform the study. Additionally, letters were written to SDOIN's Schools Division Superintendent requesting the teachers' cooperation.

After the approval sheet was approved, an internet platform was used to administer the data collection. Additionally, the URL was posted on Facebook and distributed through a chat group.

Data Analysis

Frequency counts, percentage, and mean were utilized to determine the demographic profile of physics teachers and their level of competence and the extent of using laboratory-based instruction.

Moreover, Pearson r correlation was used to determine if there is a significant relationship between profile of Physics teachers' and their level of competence in laboratory instruction.

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

Profile of Respondents

This chapter discusses the profile of Physics Teachers in the Schools Division of Ilocos Norte (SDOIN), providing insights into their demographics and professional backgrounds.

Gender

Table 1 shows the gender profile of physics teachers in the SDOIN, it reveals a significant disparity between male and female educators. Out of 198 teachers, 51 (25.76%) are male, while 147 (74.24%) are female. This indicates a clear majority of female science teachers in this division. The results implies that gender may be an important factor to consider when investigating the laboratory competence of teachers.

Teaching Position

Table 2 illustrates the distribution of teaching positions held by the science teachers in the study. The most common positions are Teacher III (42.42%) and Teacher I (22.73%), indicating a relatively even distribution between entry-level and more experienced teacher designations. Teacher II positions comprise 13.64% of the teaching force. A smaller proportion of teachers hold specialized roles such as Special Science Teacher I (3.03%) or Master Teacher I, II, and III (12.12%, 4.54%, and 1.52% respectively). A zero percentage hold the position of Master Teacher IV and Special Science Teacher II.

Although there is little representation in higher-level leadership or specialized roles, this distribution points to a teaching staff with a balanced range of experience levels. This may suggest that teachers who want to pursue leadership roles or specialized teaching tracks in scientific education may require assistance and career development opportunities. Additional research could examine the elements impacting teachers' career development and pinpoint possible obstacles to career growth.

Length of Teaching

The majority of teachers in the study has 4-7 years working experience, with the largest frequency of 54 (27.27%). 36 (18.18%) has 0-3 working experience followed by teachers that has 12-15 (15.15%) years of teaching. Moreover, the common length of teaching by science teachers are 8-11 (13.64%), 16-19 (7.58%), 24-27 (6.06%), 20-23 (4.55%) years, respectively. A smaller proportion of teachers hold longer years in the service such as 40-43 and 32-35 years (3.03%) while 1.51% has 28-31

years length of teaching. This data shows that as the length of teaching increases, the number of teachers decreases.

Highest Degree Earned

The table reveals that (18.18%) hold a Bachelor's degree with Master's Units, with 5.56% earned Bachelor's degree. 4.54% hold a Master's degree and Master's degree with doctorate units. Doctoral-level education is rare, with only 0.51%.

This implied that while most teachers meet the basic educational requirements, fewer pursue advanced studies, potentially impacting their laboratory competence. Encouraging further education could increase competence in laboratory. Further research could explore the link between teacher qualifications and level of knowledge and skills competence in laboratory.

Specialization

The last row indicates the different teachers' specialization in teaching. Among those who have, the majority (8.59) have Biology as their specialization. The number of teachers who have Physics as their specialization are 11 (5.56%) followed by 6.57% Biological Sciences. There are also 5.05% Physical Science teachers and 4.04% whom are Chemistry educators. Very few teachers have General Science (2.53%) and Science (1.01%) as their field of specialization. This could imply the importance of knowing the competence level of teachers in laboratory to ensure that they are knowledgeable enough in their field of specialization.

Table 1. The Profile of the Respondents

Socio-demographic Characteristics		f	%
Gender	Male	51	25.76%
	Female	147	74.24%
Teaching Position	Teacher I	45	22.73%
	Teacher II	27	13.64%
	Teacher III	84	42.42%
	MT I	24	12.12%
	MT II	9	4.54%
	MT III	3	1.52%
	MT IV	0	0.00%
	SST I	6	3.03%
	SST II	0	0.00%
Length of Teaching	0-3 years	36	18.18%
	4-7 years	54	27.27%
	8-11 years	27	13.64%
	12-15 years	30	15.15%
	16-19 years	15	7.58%
	20-23 years	9	4.55%
	24-27 years	12	6.06%
	28-31 years	3	1.51%
	32-35 years	6	3.03%
	36-39 years	0	0.00%
	40-43 years	6	3.03%
Highest Degree Earned	Bachelor's Degree	11	5.56%
	Bachelor's Degree w/ Master's Units	36	18.18%
	Master's Degree	9	4.54%
	Master's Degree w/ Doctorate Units	9	4.54%
	Doctorate Degree	1	0.51%
Specialization	Biological Science	11	5.56%
	Biology	17	8.59%

Socio-demographic Characteristics	f	%
Chemistry	8	4.04%
General Science	5	2.53%
Physical Science	10	5.05%
Physics	13	6.57%
Science	2	1.01%

The results of this study confirmed with the findings of Nuevo (2024), the efficiency of science teachers' use of lab materials and instructional strategies may be limited by their lack of in-service training, even if many of them hold advanced degrees, such as a Master of Arts in Education. Despite obstacles including a lack of equipment and space, teachers are generally capable of organizing and carrying out laboratory-based learning (Supriyatman et al., 2024). Additionally, some teachers thrive in physics while they need to improve in other disciplines like biology, chemistry, and earth science. This suggested that resources and training tailored to the subject are required.

In the study of Topchyan and Woehler (2020), stated that teaching position, whether full-time or substitute, can influence job satisfaction and work engagement, with full-time teachers generally reporting higher satisfaction and engagement. However, the length of teaching experience does not consistently impact job satisfaction or work engagement, nor does it significantly affect digital competence among science teachers (Kartimi, Riyanto, & Winarso, (2023).

Educational background and specialization are crucial in shaping teachers' competencies. Teachers with specialized training in STEM disciplines or higher educational attainment may possess enhanced pedagogical skills and content knowledge (Putra et al., 2022). However, some studies found no significant differences in teaching competencies based on educational attainment, indicating that other factors may also play a role (Canuto et al., 2024).

Knowledge Competence of Teachers in Science Laboratory

The ten criteria for determining the knowledge competence of scientific instructors in a laboratory were presented in Table 2. The tabulated results showed that teachers strongly agreed with three of the ten claims. With a mean score of 4.53, instructors specifically stated that they were aware of the value of laboratory techniques in scientific instruction. With mean scores of 4.33 and 4.27, respectively, they also demonstrated their understanding of laboratory safety regulations and training strategies. It was shown that teachers still do not have a basic understanding of all the scientific lab facilities and equipment, even with an overall mean of 4.08.

Table 2: Knowledge competence 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
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

Statements	Mean	Descriptive Interpretation
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**

In the study of Unyapoti et.al. (2023), revealed that teachers frequently have trouble with basic physics laboratory abilities, especially measurement and uncertainty, pointing to a training gap that needs to be filled to increase their proficiency in carrying out experiments. Conversely, science instructors typically possess a high level of knowledge and attitude about HOTS, but they only have a moderate ability to incorporate them into their lessons. This implies that in order to successfully foster HOTS in students, a wider range of tactics and methods are required (Halim et al., 2021). According to Gokmen et al. (2021), there is a need for more thorough training in laboratory procedures, as biology teachers in general are aware of lab equipment but are not familiar with how to use it.

The laboratory environment plays a significant role in developing students' science process skills. While teacher competence alone may not significantly impact these skills, a favourable laboratory environment in an online setting can lead to better acquisition of science process skills (Zabala & Dayaganon, 2023).

Skills Competence of Teachers in Science Laboratory

To make the abstract ideas taught in science classes tangible, laboratory skills must be used. Therefore, it is essential that teachers possess both the knowledge and the abilities necessary to operate lab equipment and complete lab tasks.

Table 3 indicates that instructors do believe they are very competent in laboratory skills. With mean ratings of 4.30 and 4.36, they particularly firmly agreed that they could establish and maintain a safe working environment and rigorously adhere to laboratory safety protocols. This shows that educators are capable of creating a welcoming environment in which students will learn a great deal and understand the ideas they wish to impart. On the contrary, it was revealed that teachers lack the necessary skills to operate all of the science lab equipment. The lack of proper laboratory equipment and facilities may be the source of this issue. If schools had received the funding to buy the necessary equipment, instructors might have been able to take the risk and find time to learn how to use these lab tools.

Table 3. Skills competence of teachers in science laboratory

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

Statements	Mean	Descriptive Interpretation
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**

The results of the study can be supported by Suriani et.al. (2023), results revealed that in the Science Process Skills, aspiring science teachers showed an overall competence level of 80%, which was deemed sufficient. Specific skills like classifying (87%) and observing (86%) were regarded as good, while communication (70%) was rated as noticeably weak. In the meantime, in order to create a favourable learning environment, educators need to learn how to manage social relationships and use technology (Juanda et al., 2024).

Zourmpakis et al. (2022), emphasized the value of laboratory experiences in science education. They discovered that laboratory exercises can enhance knowledge of scientific ideas, practical abilities, and favourable attitudes toward science. To maximize the advantages of laboratory operations, they also emphasized the necessity of effective planning and management.

Relationship Between Teachers' Profile and their Knowledge Competence in Science Laboratory

Table 4 presents the correlation between each of the profile of the teachers and their knowledge competence in science laboratory. Significant relationships are observed between certain factors, providing valuable insights into knowledge competence in science laboratory among teachers.

There was no significant correlation between sex and knowledge competence among teachers which indicates that gender may have a small but negative association with knowledge competence. On the other hand, teaching position shows weak positive correlations, with the highest value at 0.180 (statement 5), suggesting that higher teaching positions might have a slight influence on knowledge competence.

In terms of the length of teaching, most of the results showed weak correlation, highest being 0.133 (statement 3), which suggests limited impact on knowledge competence. Meanwhile, highest degree earned has some positive correlations, with the strongest at 0.225 (statement 3) indicating that higher education may contribute to better knowledge competence. Lastly, teachers' specialization has moderate positive correlations, the highest being 0.230 (statement 1), which suggests that specialization in a subject contributes to knowledge competence.

Table 4: Correlations between each of the teachers' profile and their knowledge competence in science laboratory

Profile	Knowledge Competence				
	1	2	3	4	5
Sex	-0.220	-0.245	-0.060	0.021	-0.053
TP	0.117	0.120	0.115	0.157	0.180
LT	0.088	0.082	0.133	0.082	0.057
HDE	0.040	0.220	0.225	0.070	0.196
S	0.230	0.049	0.049	0.183	0.147

Continuation of Table 4

Profile	Knowledge Competence				
	6	7	8	9	10
Sex	-0.117	-0.025	-0.058	-0.073	-0.178
TP	0.101	0.096	0.018	0.048	0.066
LT	0.022	0.119	-0.050	0.078	0.070
HDE	0.219	0.175	0.152	0.133	0.162
S	0.199	0.190	0.086	0.187	0.199

The results can be supported by the study of Liquido and Potane (2023), their study revealed that they don't usually considerably attenuate the relationship, variables including age, gender, and professional certification can have an impact on teachers' organizational citizenship and pedagogical knowledge competency. Khan et al. (2024), claimed that instructors' theoretical knowledge and its actual application in evaluation methods had a strong beneficial link, emphasizing the value of combining the two in teacher preparation.

Furthermore, teachers' professional knowledge, including content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK), is crucial for competence in science education. Specifically, PCK is significantly related to accuracy, indicating its importance in subject-specific diagnosis and effective teaching in science laboratories (Kramer et al., 2021).

Relationship Between Teachers' Profile and their Skill Competence in Science Laboratory

Table 5 presents the correlations between each of the profile of the teachers and their skill competence in science laboratory. Significant relationships are observed between certain factors, providing valuable insights into knowledge competence in science laboratory among teachers.

Based from the table, results revealed that sex has negative correlations, particularly at -0.272 (statement 1) and -0.244 (statement 5), which suggests that gender might negatively correlate with skill competency. Moreover, teaching position also has weak correlations, mostly near zero, implying little impact on skill competence.

Length of teaching showed mixed results with negative correlation at -0.221 (statement 4) but a positive correlation at 0.183 (statement 1), indicating an inconsistent relationship with skill competence.

Teachers' degree showed positive correlations, with the highest at 0.314 (statement 1) and 0.227 (statement 10), suggests that teachers with higher education levels may have better skill competence.

Lastly, in terms of teachers' specialization, the results showed positive correlations, with the highest at 0.127 (statement 9), indicates that specialization contributes to skill competence.

Table 5: Correlations between each of the teachers' profile and their skill competence in science laboratory

Profile	Skill Competence				
	1	2	3	4	5
Sex	-0.272	-0.171	-0.021	-0.208	-0.244
TP	0.052	0.047	-0.075	-0.054	0.103
LT	0.183	0.055	0.010	-0.221	0.042
HDE	0.314	0.191	0.076	0.088	0.206
S	0.058	0.040	0.044	0.123	0.094

Continuation of Table 5

Profile	Skill Competence				
	6	7	8	9	10
Sex	-0.172	-0.111	-0.138	-0.106	-0.071
TP	0.094	0.096	0.081	-0.006	0.087
LT	0.017	0.021	0.169	-0.005	0.129
HDE	0.123	0.076	0.182	0.068	0.227
S	0.126	0.113	0.123	0.127	0.036

The study of Nuevo (2024), supports the results by stating that teachers must receive ongoing training and professional development in order to improve their laboratory teaching abilities and make efficient use of the materials at their disposal. Creating practicum instructions and carrying out experiments are part of this. However, even when instructors are competent at organizing and carrying out laboratory exercises, they still require continual professional development to improve their abilities and adjust to changing learning contexts (Supriyatman et al., 2024).

Moreover, the relationship between teachers' profiles and their skill competence in science laboratories is multifaceted, encompassing various competencies that influence teaching effectiveness and student outcomes. Research indicates that teachers' educational backgrounds, professional experiences, and participation in scientific activities significantly impact their ability to utilize laboratory equipment effectively, which in turn enhances student engagement and learning outcomes (Annisa et al., 2024).

According to Ecevit and Kaptan (2022), their study states that engagement in workshops and scientific communities enhances teachers' knowledge and skills, leading to improved laboratory teaching practices.

Implications to Physics Teaching

Based from the results of the knowledge competence and skill competence of Physics teachers in laboratory instruction, it could imply that students are probably going to get excellent, practical learning opportunities that improve their comprehension of physics ideas. Stronger problem-solving abilities, better conceptual learning, and increased student engagement can result from this. It might also suggest that schools offer sufficient tools and instruction for lab work, encouraging a more experimental and inquiry-based approach to physics instruction. But it also puts more pressure on educators to successfully convert their knowledge into effective teaching strategies so that every student gains from real-world applications of physics concepts.

The study of Supriyatman et. al. (2024), effective laboratory instruction requires sufficient space, equipment, and support personnel, among other resources. By attending to these needs, laboratory instruction and learning can be made better. Furthermore, in order to preserve and improve their instructional competencies—particularly when it comes to adjusting to new teaching approaches and technologies—teachers must participate in continuous training and development programs (Gayon, 2023).

Conclusion

In the study, it revealed that teachers have high knowledge and skill competence when it comes to laboratory instruction. Additionally, gender (sex) negatively correlates with knowledge and skill competency. This implied that male and female teachers may have different competency levels. Moreover, higher degrees and teachers' fields of specialization contribute positively to both knowledge and skill competence in science laboratory instruction. In addition to this, teaching position and length of teaching have weak indicating that experience alone may not strongly influence knowledge and skill competency in science laboratory. Lastly, teachers' knowledge and skill competence have a lot of possible impact to students and to their teaching.

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