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research ARTICLE

JOURNAL OF REGIONAL STUDIES REVIEW (JRSR)

Investigating Science Teachers' Competencies in Laboratory Practical Work at the Secondary School Level

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Abstract: The study investigated science teachers' competencies in laboratory practical work at the secondary school level in the district of the Lakki Marwat. The main objective of the study was to investigate science teachers' competencies in laboratory practical work at the secondary school level. The research question of the study was: What was the status of science teachers' competencies in laboratory practical work at the secondary school level in the district of the Lakki Marwat? Research designused was descriptive survey was used to conduct the study. The population consisted of science teachers teaching chemistry, heads of schools, and Grade 10 science students in all 62 schools of boys in the district of the Lakki Marwat. A sample of 46 schools was selected through simple random sampling. Accordingly, 46 science teachers teaching chemistry, 46 heads of schools, and five Grade 10 science students from each selected school, making a total of 230 students, were included in the sample. Three separate questionnaires were used to collect data from science teachers, heads of schools, and students. The data obtained through these instruments were analysed using descriptive statistics, particularly frequencies, percentages, and arithmetic means. The study found that science teachers teaching chemistry demonstrated competencies in knowledge of laboratory practical work content, motivation, monitoring, communication, demonstration, teamwork, and technical knowledge. However, they showed weaknesses in the regular conduct of practical work, assessment, ICT usage, safety practices, preparation of materials, and report writing. It was recommended that science teachers teaching chemistry should conduct all laboratory practical work activities prescribed in the curriculum and ensure their regular implementation. Furthermore, they should be trained in the operation of ICT applications and the implementation of laboratory safety practices.

Keywords: Science Teachers' Competencies, Laboratory Practical Work, Chemistry Practical Work, Secondary Level School, Science Education

Introduction

Science education plays a diverse role in making a stable society. It ensures socioeconomic development. That is why it has been given great importance in every society. Faize and Dahar (2011) considered a good science education program a basic instrument for social and economic development. According to Rehman (2004), it has been seen that science has an important place as a powerful tool for socioeconomic changes and development and advancement of the nations. It is a human endeavor and has influenced all walks of life.

At secondary level, science education has its own importance. Secondary education is considered an important level in education system. It makes a link between elementary and higher education. It provides human resources of moderate standard to a society on one hand and, on the other hand, makes a basis for

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higher education. Zengele and Alemayehu (2016) stated that science education of a good quality at secondary level plays a major role in developing scientific literacy. Meanwhile, it also prepares students to study science at higher level.

To achieve fruitful results, science teaching should be accompanied by laboratory practical work. Various terms, including practical, practical work, experimental work, laboratory work, laboratory activities, etc., are used for laboratory practical work in the literature. In the present study, laboratory practical work means all the practical work conducted in a secondary school science laboratory by science group students under the guidance of their science teacher. Laboratory practical work for science subjects in schools is very essential. Science laboratory is an important place in a secondary school. A secondary school without a standard science laboratory is like a body without soul. It is necessary to provide each secondary school with science laboratory (Suryanti & Hidayati, 2016).

Olatunde (2010), citing Ogunniyi (1982), stated that science educators acknowledge the central position of laboratory in science teaching because it is the place where theoretical work is changed into practical experiences. Practical work engages students in activities of observing, counting, measuring, experimenting, recording and carrying out field work. Proper and accurate laboratory practical work is possible in schools where standard laboratory facilities and competent science teachers are available.

Laboratory practical work is a central component of high-quality science education because it provides learners with direct experience of empirical investigation, helps develop procedural and inquiry skills, and links theoretical knowledge with observation (National Research Council, 2005). However, the educational value of practical work depends heavily on teachers' competencies, including content knowledge, pedagogical content knowledge for laboratory tasks, technical/procedural skills, and laboratory management (Abrahams & Millar, 2008; Oliveira et al., 2023). International and country-level studies indicate that unless teachers are competent in these domains, laboratory activities may become limited to confirmation or demonstration tasks and may fail to generate the intended conceptual understanding and process skills among students. In Pakistan, emerging empirical research similarly reported gaps in laboratory facilities, teacher preparedness, and targeted professional development that limit the effectiveness of practical work at the secondary level (Al-Qamar & Malik, 2025; Rafique, 2024; Shahzadi et al., 2023).

Science teachers' competencies in laboratory practical work refer to the skills and personality of a teacher in conducting the teaching process with the help of teaching methods, handling practical work, teaching aids and resources (Copriady, 2014). In this study, science teachers' competencies are related only to science laboratory Practical work.

Copriady (2014) summed up these competencies in four categories:

1. **Designing a Practical/Experiment:** Designing a practical or experiment involves planning a systematic investigation to answer a scientific question or test a hypothesis. It includes identifying variables, selecting appropriate materials and procedures, and ensuring the investigation is safe, fair, and capable of producing reliable and valid results.
2. **Planning a Practical/Experiment:** Planning a practical or experiment involves organizing the sequence of activities, selecting suitable apparatus and resources, and allocating time to ensure the investigation is conducted efficiently. It also includes anticipating potential challenges, incorporating safety measures, and preparing methods for accurate data collection and analysis.
3. **Implementing a Practical/Experiment:** Implementing a practical or experiment involves carrying out the planned procedures systematically while adhering to scientific methods and laboratory safety guidelines. It requires careful observation, accurate measurement, and precise recording of data to ensure reliable and meaningful results.
4. **Evaluating a Practical/Experiment:** Evaluating a practical or experiment involves assessing whether the investigation achieved its objectives and produced valid and reliable results. It includes analyzing

the data, identifying sources of error or limitations, and suggesting improvements to enhance the accuracy, effectiveness, and quality of future investigations.

The process of teaching science can be made effective through practical work. Science is the knowledge about nature and naturally occurring events and phenomena. It involves investigation, research and discovery through experimental work in the science laboratories under the guidance of Science teachers or lecturers (Copriady, 2014). Science subjects essentially include practical work. Curricula provide a list of practical work in the science subjects, i.e Biology, Chemistry and Physics and also guidelines for science teachers. The purpose is to provide opportunities to the science students to practice the process of investigating and verifying scientific knowledge. All this may involve the work of science students in well-equipped and supported laboratory environment. Practical work is essential in secondary schools as it helps students in verifying and understanding the theoretical knowledge of science subjects (Zengele & Alemayehu, 2016).

Statement of the Problem

The transformation and advancement of science at secondary school level requires competent science teachers who can effectively conduct laboratory practical work. Zengele and Alemayehu (2016) were of the view that committed science teachers could achieve the goal of laboratory practical work in science and could provide students with a relevant experience. The present study was therefore conducted to determine status of science teachers' competencies in laboratory practical work at the secondary school level in district of Lakki Marwat.

Purpose of this Study

The Purpose of the study was to investigate the status of science teachers' competencies in laboratory practical work at the secondary school level in the district of Lakki Marwat.

Research Question of the Study

Based on the stated problem, the study attempted to answer the following question.

- What was the status of science teachers' competencies in laboratory practical work at SSC level in the district of Lakki Marwat?

Significance of this Study

The study investigated science teachers' competencies in laboratory practical work at the secondary school level. It may provide science teachers with an understanding of the competencies required for effective laboratory practical work. The study may also help school heads to ensure the proper conduct of laboratory practical work in their schools. Moreover, it may draw the attention of higher authorities towards arranging professional development programs in laboratory practical work for science teachers. The study may also provide a basis for improving the existing situation of the laboratories and enhancing science teachers' competencies in laboratory practical work.

Delimitations of the Study

The delimitations of the study were:

- Only government high schools for boys were included.
- Science teachers' competency was investigated only in relation to chemistry laboratory practical work.
- The study focused on science teachers teaching chemistry, heads of schools, and Grade 10 science students.

The researcher delimited the study only to boys' government high schools in district Lakki Marwat. It would have been of great importance if the study had been extended to other districts of Khyber Pukhtunkhwa and included girls and private schools. In that way, other parameters such as gender-based, urban-rural and public-private comparison could also have been examined. However, due to cultural

considerations and time and resource constraints, the researcher collected data only from the students, teachers and headmasters of high schools located in the district of Lakki Marwat.

Review of the Related Literature

A science teacher professionally competent in laboratory practical work may easily improve science students' learning if standard science laboratories are provided in schools. Science teachers' competencies represent the knowledge, skills and dispositions that are believed to be very important for teachers. These competencies can be found in constructivist courses in the arena of science. Science teachers' competencies, as summarized by Nezvalová (2007), are discussed as;

- Competency of Understanding Nature and Content of Science
- Competency of Inquiry
- Competency of General Skills of Teaching
- Competency of Curriculum
- Competency of Assessment
- Competency of Professional Practice

The National Science Teachers Association (NSTA, 2003) established certain standards for competent science teachers. Actually, these standards are described for science teacher preparation. These standards include that science teachers must have complete knowledge of content of science, nature of science, Inquiry, issues related to science and technology, general skills of teaching, curriculum, science in community, assessment, safety and welfare and professional growth according to students' and school and community needs. Suryanti and Hidayati (2016) highlighted the following teachers' competencies that are required for management of science laboratories.

Personality Competences

It requires that a science teacher should be noble, stable and mature. Science teacher should show dedication to job.

Social Competences

It includes skills of doing a job in teams, being outspoken, and being able to effectively communicate in verbal and non-verbal ways.

Administration Competences

It highlights:

- Planning for proper utilization of school laboratory.
- Arrangement of equipment, storage materials and other tools of laboratory.
- Making of research materials and noting the whole phenomenon of research

Management Competencies

It refers to:

- Planning the science lab activities and development of laboratory in school.
- Management and supervision of laboratory activities
- Assigning job tasks to persons working in the laboratory.
- Monitoring the Infrastructure and facilities in science laboratory

Professional Competences

It includes:

- Application of ideas, principles, and theories regarding laboratory activities of school.
- Utilization of the laboratory for educational skill development and research

- Preparing for laboratory activities and roles
- Managing the laboratories in the Schools
- Maintenance of tools and materials in laboratory.
- Management of materials and laboratory equipment
- Serving lab activities

Chemistry is one of the science subjects that requires proper laboratory practical work. The objectives of chemistry teaching can be achieved easily through laboratory practical work. The importance of laboratory practical work for study of chemistry at secondary level needs not to be overemphasized. Ibe et al. (2013), quoting Njoku (2003), stated that the subject of chemistry is a practically oriented subject, and it is essential to create students' interest in chemistry practical work so that they get mastery of the subject. The purpose behind this is to enable the students to get the science process skills which are essential for proficiency in scientific tasks. According to Nadeem et al. (2025), teachers differ in their competencies across different sectors.

Akani (2015) mentioned that theoretical teaching of chemistry without doing suitable practical work in secondary schools' science laboratories affects students negatively. Consequently, students will be:

- Lacking scientific attitude
- Lacking problem solving and problem solving skills.
- Lacking scientific inquiry skills
- Lacking acquisition of scientific skills
- Lacking scientific research environment
- Lacking in learning chemistry
- Performing poorly in practical chemistry.

Chemistry education includes more laboratory practical work than any other science subject. It demands some sort of practical and experimental activities at each level of education. Practical part is a basic part of any science course, but in case of chemistry subject, it is more special and fundamental (Reid & Shah, 2007). Laboratory practical work in chemistry requires certain special competencies. These competencies can be summed up as follows:

- Knowledge of the content of chemistry laboratory practical work

For a chemistry teacher, it is necessary to have knowledge about the content of laboratory practical work. What to be done? And what kind of practical work to be conducted in the laboratory requires prior knowledge and understanding of that work. Copriady (2014) suggests good knowledge of the content (theory and practical) of chemistry curriculum for the improvement of teachers' competency.

Moreover, it is the responsibility of a teacher to determine how much content knowledge is essential for learners to be taught before starting any practical work in the laboratory. Even Johnston and al-Shuaili (2001) consider understanding of content a prerequisite for students. Without proper knowledge of the content, practical work, which is like an investigation, cannot be performed well. Ministry of education, Government of Pakistan, has devised the Chemistry Curriculum 2006 for secondary level, which includes the content of laboratory work.

Suryanti and Hidayati (2016) conducted a study in order to determine teachers' competencies in the management of science laboratories in public secondary schools in Indonesia. They included the following competencies under various constructs in the questionnaire used for data collection.

- Capability to organize chemistry laboratory effectively.
- Ability to manage class effectively in the laboratory.
- Capability to communicate with students effectively in the laboratory.
- To have good teamwork with students in doing laboratory practical work.

Faize (2011b) devised a questionnaire in order to explore the competency level of physics teachers in practical work. Some of the competencies used in that questionnaire can also be useful for chemistry laboratory work, which are:

- Ability to prepare various materials used in chemistry laboratory practical work.
- To get experimental values close to the actual.
- Ability to set up apparatus for chemistry laboratory practical work.

Baily and Barwick (2007) described basic laboratory practical work skills for chemistry, including measuring volume, mass and pH, preparing solutions of known concentration and reagent solutions and carrying out a titration. It also includes some other basic techniques of glass cutting, bending of glass tubes, making a jet, cork boring, making a wash bottle and measuring the density of a substance. Moreover, knowledge about important physical methods used in chemistry laboratory work is also an important skill. Important physical methods are evaporation, filtration, distillation, sublimation, etc.

Afemikhe et al. (2015) mentioned the following science practical skills for secondary school teachers.

- Observing and monitoring students doing laboratory practical work in laboratory
- Ability to prepare laboratory practical work reports.
- Encouraging students to write reports of laboratory work conducted in laboratory.
- Assessment of student laboratory practical work.

Teacher should monitor and observe students while they are busy doing laboratory practical work. Teacher should give proper individual attention to each student. If a student faces certain problem during practical work or asks any question, they should be properly guided by the teacher. Furthermore, making and writing laboratory work report is one of the basic competencies required for laboratory practical work. Similarly, students should be encouraged to write reports of laboratory work.

Assessment of students' laboratory practical work is also included in the competencies of a teacher. However, students' ability in laboratory practical work should not be assessed through the laboratory work reports they have written. However, they should be assessed while they are busy conducting laboratory practical work. According to Johnston and Al-Shuaili (2001), the assessment of laboratory work reports may measure the power of students to observe and their ability to interpret observations and results. But it would not assess appropriate manipulative skills of students and their ability to plan experiments, which are the basic outcomes of laboratory practical work.

After assessment, proper feedback should be given to students so that they can remove their shortfalls. Moreover, teachers should try to modify instruction as needed according to the circumstances. Sudijono and Djamarah (as cited in Copriady, 2014) discussed that the ultimate function of assessment is to get and to provide feedback.

Copriady (2014) pointed out that a competent chemistry teacher is able to use a variety of instructional methods and teaching aids and is efficient in using and setting up various equipment and apparatus. Teacher is also skillful in ensuring safety during laboratory practical work.

Some other competencies required for chemistry laboratory work may include;

- To allocate proper time for chemistry laboratory practical work in the academic year.
- To conduct chemistry laboratory practical work regularly.
- Ability to motivate students for chemistry laboratory practical work.
- The ability to plan well before conducting any practical in the laboratory.
- To demonstrate chemistry laboratory work well before the class.
- Good observation skills to determine values
- To motivate students to take keen interest in chemistry laboratory practical work.
- Doing all the laboratory work included in the course for lower secondary school students.
- Ability to use ICT in chemistry laboratory practical work.

- To use laboratory in chemistry teaching.

(NSTA, 2006; NRC, 2006).

Related Research Studies

Rehman (2004) found in his research study that in the curriculum of chemistry, the theoretical and practical components were not properly arranged.

Iqbal (2004) mentioned some problems after conducting his research study. These include, among others, an examination system focused on memorization and proper practical work not being conducted regularly.

Faize (2011a) conducted a study on problems and prospects in science education at secondary level in Pakistan. The objective of the study was to identify the shortcomings in the pre-service training of science teachers of the secondary level. He found that in teachers' pre-service training, theoretical aspect is more emphasized while practical component is neglected. However, it was good.

Faize (2011b) compared the views of 'O' Level Federal Board students about their physics teachers' competencies in practical skills. They found that physics teachers of both the systems were competent in setting up physics apparatus for experiments. However, the 'O' Level physics teachers were more competent in identifying experimental errors, in getting the correct experimental values and in designing new practical arrangements. But both kinds of physics teachers were not able to design low-cost teaching aids.

Zaman et al. (2012) conducted a study to explore the impact of pre-labs in chemistry laboratory at secondary level. 119 boys and 116 girls studying chemistry at secondary level were selected as sample for the study. Both kinds of samples were divided into control group and experimental group. They conducted experimental research. The results revealed that pre-lab has improved students' understanding in chemistry. It was also found that pre-lab has strong effect on the improvement of academic achievement of boys more than that of girls.

Awan (2015) viewed that teachers in majority of the schools (except in 8%) were trained teachers. But, majority of the science teachers did not use laboratory during teaching science. And, majority of the teachers were not able to conduct practicals due to workload and shortage of time required for completion most of the time.

Feyzioglu (2009) investigated that laboratory applications improve students' science process and problem-solving skills and improve students' interest and attitude according to the objectives of science education.

Odum et al. (2013) assessed the quality of secondary-school chemistry teachers in Cross River State, Nigeria, by examining their ability to identify and use laboratory apparatus. The study aimed to establish teachers' competence in laboratory activities by assessing whether they could write the names of common laboratory apparatus and explain their uses. It also investigated the extent to which teachers' gender and school location influenced this competence. Data were collected using an instrument developed for the study, the Laboratory Apparatus Identification and Use Questionnaire (LAIUQ). The findings indicated that most teachers were unable to identify, by writing the names and uses, 84.50% of the commonly used laboratory apparatus. Teachers' gender and school location significantly influenced their ability to identify and use laboratory apparatus. They recommended that state arrange training programs for teachers to improve their competencies in the usage of laboratory apparatus by making them familiar with apparatus and their use. Moreover, they suggested building well-equipped laboratories in schools.

Copriady (2014) conducted a study in Indonesia. The aim of the study was to determine the contribution of teachers' competency in teaching and learning practical chemistry from the interrelated aspects of designing, planning, implementing, and evaluating practical training or experiments in improving the quality and standards of teaching and learning practical chemistry. The sample of the data was selected randomly

and included 234 chemistry teachers in Riau, Indonesia. A questionnaire was used to collect the data. The results showed that teachers' competency in all four aspects of designing, planning, implementing, and evaluating chemistry practicals was at a moderate level. He recommended that strategic efforts should be taken to make the teachers able to handle the chemistry practical effectively.

Olubo (2015) conducted a research study to find out the influence of science laboratory on learning outcomes of students in the subject of chemistry at secondary school level in Ondo State, Nigeria. The result showed that there is a significant relationship between laboratory environment and students' performance in chemistry.

Akani (2015) recommended that science teachers should be qualified and chemistry teaching should be done in the laboratory.

Akanbi and Omosewo (2018) revealed through their study that students taught by qualified and experienced teachers performed better than those taught by unqualified and less experienced teachers. It was also found that students exposed to the use of laboratory showed better results than those not exposed to laboratory.

Research Methodology

The study employed a descriptive survey research design to investigate science teachers' competencies in laboratory practical work at the secondary school level in the district of Lakki Marwat.

Population of the Study

The population of the study consisted of science teachers teaching chemistry, heads of schools and Grade 10 science students in all 62 government high schools for boys in the district of Lakki Marwat.

Table 1

Population of Respondents for Science Teachers' Competencies in Laboratory Practical Work

Category	Population
Science Teachers	62
Heads	62
Students	1844
Total	1968

Sample of the Study

Forty-six (46) government high schools were selected through simple random sampling technique to make sample for the study. Accordingly, one science teacher teaching chemistry and one head from each of the 46 schools were included in the sample. In a school where there was more than one science teacher teaching chemistry, one teacher was selected through simple random sampling. In addition, five science students of Grade 10 were selected randomly from each of the 46 selected schools for sample. Thus, the sample consisted of 46 science teachers teaching chemistry, 46 heads of schools and 230 students.

Table 2

Sample of Respondents for Science Teachers' Competency in Laboratory Practical Work

Category	Sample Size
Science Teachers	46
Heads	46
Students	230
Total	322

Instruments of the Study

Three separate questionnaires were used for data collection. The first questionnaire was designed for science teachers teaching chemistry, the second for heads of schools, and the third for Grade 10 science students in the selected government high schools.

These questionnaires were developed after a comprehensive review of the National Curriculum for Chemistry, Grades IX–X (Government of Pakistan, 2006), the Laboratory Skills Training Handbook (Bailey & Barwick, 2007), America's Lab Report: Investigations in High School Science (National Research Council, 2006), National Science Teachers Association reports, and other relevant literature. Moreover, the opinions and suggestions of the experts in science laboratory practical work were considered during the development of the instruments.

The questionnaires consisted of 30 items covering different competencies, including the capability to organise the Chemistry laboratory, allocation of appropriate time for Chemistry laboratory practical work, knowledge of the content of Chemistry practical work, knowledge of basic laboratory techniques, and knowledge of important physical methods used in Chemistry laboratory practical work.

In order to validate the instruments, the three drafts were distributed to experts in science education and chemistry laboratory practical work and educational research to ensure the relevance, clarity and appropriateness of items. The suggestions of the experts were incorporated before the final administration. The reliability was assessed through pilot study conducted in schools not included in the sample. Cronbach's alpha coefficient was calculated separately for each questionnaire to determine its internal consistency. The reliability coefficients were .80 for the science teachers' questionnaire, .85 for heads and .75 for students. These values indicated acceptable to good internal consistency, confirming that all three questionnaires were reliable for data collection. And, finally, this led to the refined form of instruments, which were valid and reliable and were ready to be administered for data collection.

Procedure for Data Collection

After getting permission from the District Education Officer, Elementary and Secondary Education District Lakki Marwa, the researchers personally visited all selected schools. The respondents were informed that the data collection was solely for research purposes and would remain confidential. Their informed consent was also obtained before starting to administer questionnaires. After that, science teachers teaching chemistry and heads of the schools were asked to fill out their respective questionnaires. Regarding students, questionnaires were given to five science group students of Grade 10 in each school included in the sample on the same day of the visit. The researcher personally supervised that process. Students were guided and assisted in completing their respective questionnaires. In this way, the required data for the study were collected from all three categories of respondents.

Analysis and Interpretation of the Data

The data obtained through the three questionnaires were tabulated. Each item had five responses: strongly agreed with 5 points, agreed 4 points, undecided 3 points, disagreed 2 points and strongly disagreed 1 point. Frequency distribution of the responses for each item was made.

An appropriate statistical technique, including percentage and arithmetic mean with the help of Microsoft Excel (a computer application), was then applied for each item. Mean score of 3.5 was taken as favorable to the statement. Any item with a mean score of 3.5 and above was interpreted as agreeing, while mean scores below 3.5 were regarded as disagreeing with the statement. This led to the conclusion of study in respect of science teachers' competencies in laboratory practical work at secondary school level in district Lakki Marwat. Finally, recommendations were stated.

Table 3

Science Teachers' Competencies in Laboratory Practical Work

Item No.	Statement	Science Teachers (Mean)	Heads (Mean)	Students (Mean)
3.1	Capability to organize chemistry laboratory effectively.	4.00	3.98	3.90
3.2	Allocating proper time for chemistry laboratory practical work in the academic year.	4.33	3.56	4.02
3.3	Conducting chemistry laboratory practical work regularly.	2.76	2.26	2.54
3.4	Ability to manage class effectively in the laboratory.	4.26	3.64	4.21
3.5	Capability to communicate students effectively in the laboratory	4.30	3.52	4.19
3.6	Having good team work with students doing laboratory practical work	4.26	3.67	4.03
3.7	Ability to motivate students for laboratory practical work	4.33	3.65	4.07
3.8	Knowing content of chemistry laboratory practical work	4.35	3.73	3.86
3.9	Knowledge of basic laboratory practical work techniques required for chemistry laboratory practical work.	4.34	3.73	4.15
3.10	Knowledge of important physical methods used in chemistry laboratory practical work	4.39	3.80	3.95
3.11	Ability to plan well before conducting practical activities in the laboratory.	3.65	3.54	4.14
3.12	Ability to demonstrate chemistry laboratory practical work effectively.	4.30	3.30	4.03
3.13	Ability of setting up apparatus for chemistry laboratory practical work	4.13	3.23	3.82
3.14	Awareness about various chemicals used in chemistry laboratory.	4.36	3.97	4.09
3.15	Ability to use chemistry laboratory equipment effectively.	4.30	3.80	4.34
3.16	Observation skill for determining values.	4.15	3.26	4.32
3.17	Ability of getting experimental values close to the actual, often times.	3.63	3.26	3.87
3.18	Ability to prepare laboratory work reports	3.39	3.28	4.19
3.19	Ability to prepare various materials used in chemistry laboratory practical work.	3.37	2.87	3.76
3.20	Ability to monitor students doing laboratory practical work.	4.32	3.59	4.19
3.21	Ability to give individual attention to each student during laboratory practical work.	4.35	3.96	4.18
3.22	Ability of making laboratory practical work interesting for students.	4.17	4.02	4.04

Item No.	Statement	Science Teachers (Mean)	Heads (Mean)	Students (Mean)
3.23	Ability to encourage students to write report of laboratory practical work conducted in the laboratory	4.30	3.61	4.20
3.24	Ability to assess students laboratory practical work regularly.	2.70	2.63	2.62
3.25	Ability of providing feedback to students about laboratory practical work.	3.46	3.17	4.13
3.26	Competency use assessment results to modify instruction as needed.	4.39	3.37	4.02
3.27	Ability to conduct all the laboratory work included in the course.	2.60	2.78	2.90
3.28	Awareness of safety precautions required for chemistry laboratory practical work.	2.97	2.89	2.46
3.29	Skill of using ICT in chemistry laboratory practical work	2.82	2.87	3.17
3.30	Ability to use laboratory during teaching of chemistry.	4.22	3.61	4.12

Table 3 presents mean scores from science teachers, heads, and students across 30 competency items with their respective statements.

The analysis of responses from science teachers, heads, and students provides a clear picture of strengths and weaknesses in science teachers' competencies in laboratory practical work at secondary school level. Competencies related to knowledge about content of laboratory practical work, allocation of proper time in the academic year, motivation, monitoring, communication, demonstration, teamwork, management and organization during laboratory practical work were generally rated above the benchmark mean score of 3.5. Teachers rated themselves highly in these areas of competencies (M=4.35), (M=4.33), (M=4.33), (M=4.32), (M=4.30), (M=4.30), (M=4.26), (M=4.26), (M=4.00), respectively. Heads and students gave slightly lower but still acceptable ratings in these domains, showing that teachers possess the subject mastery and pedagogical skills required to conduct laboratory activities.

Technical knowledge was also positively rated, with teachers showing strong command over physical methods (M=4.39), laboratory techniques (M=4.34), and effective use of equipment (M=4.30). Students supported these findings, particularly in observation skills (M=4.32) and equipment use (M=4.34). This suggests that teachers are capable of handling practical tools and guiding students effectively in experimental work. Observation skill (M=4.15), competency in setting up apparatus (M=4.13), and ability to get experimental values close to the actual (M=3.63) were positively reported by science teachers. Students also rated positively, but Heads diverged from the views of science teachers and students.

In contrast, some competencies fell well below the benchmark, indicating significant weaknesses. The most notable gap was in the regular conduction of laboratory practical work (Teachers M=2.76, Heads M=2.26, Students M=2.54), and regular assessment of students' practical performance (Teachers M=2.70, Heads M=2.63, Students M=2.62). Safety precautions (Teachers M=2.97, Heads M=2.89, Students M=2.46) and ICT integration (Teachers M=2.82, Heads M=2.87, Students M=3.17) also scored poorly, showing that both safety culture and digital tools were underutilized in laboratory practice. Furthermore, teachers were not able to conduct all prescribed experiments (M=2.60–2.90) or prepare required materials consistently (M=3.37, 2.87, 3.76) and were also weak in preparing laboratory practical work reports (M=3.39, 3.28, 4.19).

Figure 1

Status of Science Teachers' Competencies in Laboratory Practical Work

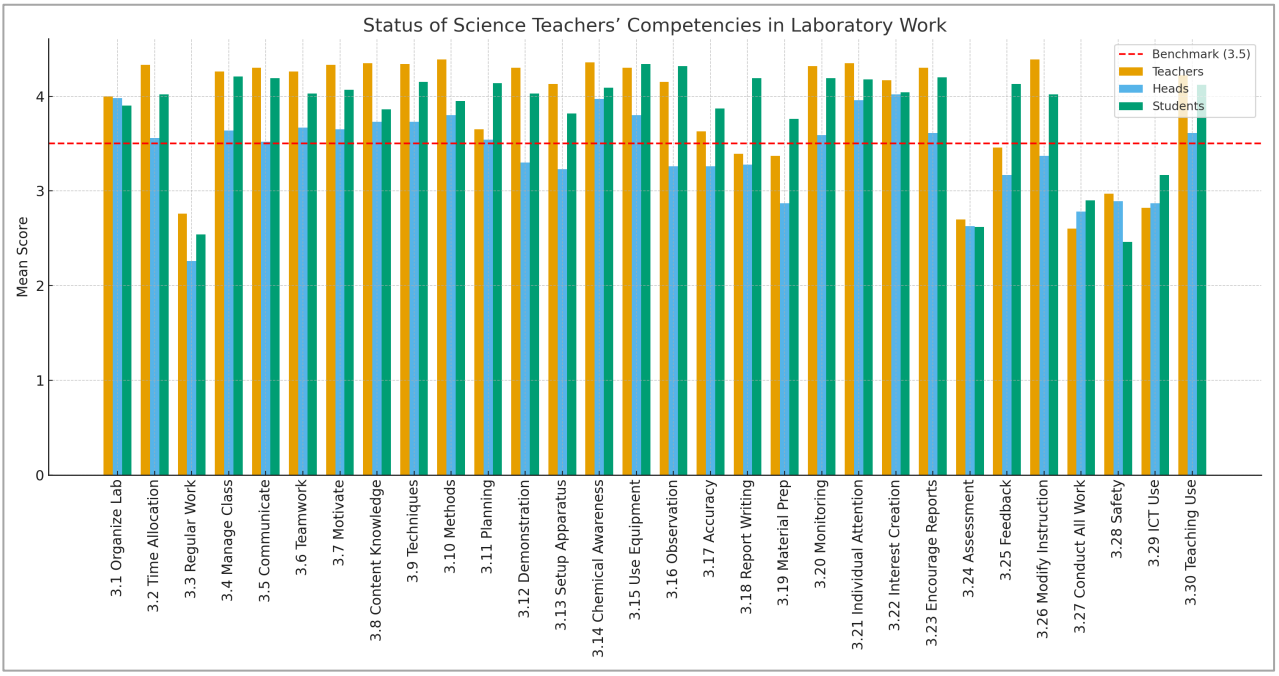


Figure 1 presents the mean scores of science teachers' laboratory practical work competencies as perceived by teachers, heads, and students. The red dashed line indicates the 3.5 benchmark of competency. It can be observed that teachers generally rated themselves higher than heads, while students' ratings were mostly consistent with teachers'. Some competencies, such as regular laboratory practical work, safety, ICT use, and assessment, scored below the benchmark across groups.

In general, science teachers demonstrated competence in knowing about content of laboratory practical work, motivation, monitoring and communication, demonstration and teamwork and technical knowledge, but fell short in regular practice, assessment, ICT usage, safety, material preparation and report writing of laboratory practical work.

Discussion

The findings of this study revealed a complex situation regarding science teachers' competencies in laboratory practical work at secondary school level. While certain strengths were evident, significant challenges persisted, particularly in the areas of practical implementation, safety protocols, and ICT integration.

Teachers demonstrated proficiency in organizing laboratory sessions, managing classrooms effectively, and conveying subject knowledge. These competencies align with the findings of a study conducted in Hyderabad District, which assessed the current competencies of science subject teachers in practical/laboratory work. The study highlighted that teachers were generally capable in organizing and conducting laboratory activities, despite facing infrastructural challenges (Dilshad, 2025).

Despite the strengths mentioned above, teachers scored below the benchmark in areas such as conducting regular practicals, assessing laboratory practical work, and ensuring safety precautions. A study focusing on the effectiveness of science labs at the secondary school level in Pakistan reported that many schools lack the necessary resources and facilities to conduct regular practical sessions. This shortage of resources often leads to teachers skipping or shortening practical sessions, thereby affecting the quality of science education (Dilshad, 2025).

The study also revealed persistent weaknesses in laboratory safety practices. Teachers' awareness and implementation of safety measures were found to be inadequate. Research on the role of laboratories in

science teaching and student learning at the secondary level in public schools indicated that the lack of proper safety protocols and training contributes to a hazardous learning environment, which can deter effective science teaching and learning (Shahzadi et al., 2023).

Another significant challenge identified was the limited integration of Information and Communication Technology (ICT) in laboratory sessions. A study examining the integration of ICT in science education in Pakistan highlighted that while digital technologies are increasingly viewed as essential in science education worldwide, Pakistani schools often face barriers such as lack of equipment and insufficient training for teachers. This gap in ICT integration hampers the potential for enhancing interactive and modern science education (Lawal, 2024).

The study conducted by Irfanullah et al. (2025) entitled "Factors Affecting Science Teachers during Performing Laboratory-Work at Secondary Level" also aligns with this study on two findings regarding availability of required quality of equipment, which affect the science teachers' competencies, and second was the availability of ICTs.

Conclusion of the Study

Overall, this study demonstrated that while science teachers were competent in theoretical, organizational, and communicative aspects and technical procedures of laboratory work, they remained weak in regular practice and assessment of laboratory practical work, ICT usage, safety, material preparation and report writing of laboratory practical work. The findings were consistent with other related research studies, highlighting the need for stronger professional development in safety protocols and ICT training.

Recommendations

The study revealed that science teachers were competent in theoretical and technical aspects of laboratory practical work. However, they were unable to use ICT and were also unaware of safety precautions required for laboratory practical work. It is, therefore, suggested that higher authorities arrange training programs for science teachers. These programs should enable science teachers to operate ICT applications and become aware of safety precautions. International studies suggested that professional development combining modeling of inquiry tasks, collaborative lesson design, and classroom-embedded coaching is most effective for changing teachers' lab practice (Seery, 2024). Moreover, Pakistan-focused reviews and empirical studies also recommend that professional development should be context-sensitive and focused on locally available materials, simple low-cost inquiry sequences, and practical assessment rubrics (Al-Qamar & Malik, 2025). Moreover, science teachers should conduct all the laboratory practical work included in the course. They should conduct laboratory practical work regularly. Furthermore, school administration should facilitate science teachers in this regard.

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