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Competence of Junior high Schools' Science Teachers in Implementing Laboratory Teaching: A Case Study on Palu, Centre Celebes

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Abstract: This research investigates the competence of junior high school science teachers in Palu City, Indonesia, regarding laboratory teaching. The study aims to assess teachers' abilities in planning, implementing, and evaluating laboratory-based learning. Data were collected through observations, document reviews, and interviews with science teachers across six public junior high schools. The findings reveal that all schools engage in laboratory learning to some extent, with varying degrees of success. Teachers often create their own worksheets or use existing guides from science kits. Challenges identified include insufficient laboratory space, incomplete equipment, and a lack of dedicated laboratory assistants. Despite these obstacles, science teachers collaborate to ensure effective laboratory learning, highlighting the need for improved resources and support to enhance the overall quality of science education. The study concludes that while teachers demonstrate competency in laboratory teaching, further development is needed in creating practicum guides, conducting experiments, and assessing student skills. Future research should explore the impact of teacher competence on student learning outcomes in laboratory settings.

Keywords: Laboratory learning; Nature of science: Science teacher competence

Introduction

Science skills are integral to the scientific process, combining experiments and theoretical study to develop laws, concepts, and theories. A positive scientific attitude helps students form good character and practical skills. Laboratory activities enhance students' understanding of science, stimulate analytical and critical thinking, and generate interest in science (Abdurrahman et al., 2023; Nisa et al., 2023; R. P. Sari et al., 2020; Zulkifli et al., 2022). They support learning by improving students' comprehension of studied material and developing experimental abilities. However, challenges in laboratory learning, such as inadequate facilities and lack of practice, hinder effective science education (Jannah et al., 2020; D. K. Sari et al., 2022; Syam et al., 2023). This research examines the competence of science teachers in using laboratories for science process learning activities. This shows that science does not only study things in theory but also with practice (Potkonjak et al., 2016; Salabi, 2016; Son et al., 2016). Laboratory activities can assist students in learning science through sharpening concepts of knowledge, and also help to develop their understanding of the nature of science and

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its methods, and know how to apply science (Abdurrahman et al., 2023; Azhar et al., 2022; Dewi et al., 2022; Elisa et al., 2023). Laboratory activities can also stimulate the development of analytical and critical abilities, as well as generate an interest in science (Clair et al., 2020; Ismail et al., 2022).

The laboratory as a place for observation, experimentation, training, concept testing, knowledge, and technology, is expected to be a means of learning processes that improve student achievement. One of the science learning methods that can create the achievement of science scientific concepts and science scientific process components is to carry out learning in the laboratory in the form of a practicum (Bretz, 2019; Buck et al., 2008; Fay et al., 2007; Potkonjak et al., 2016; Salabi, 2016; Salmerón-Manzano & Manzano-Agugliaro, 2018; Son et al., 2016). Practicum activities can generate student learning motivation. Through practicum activities, students are allowed to increase student curiosity. This will support students to find knowledge through exploration (Hermawan et al., 2020; Isozaki, 2017; Kim et al., 2019; Orhan & Sahin, 2018).

The laboratory is a place to carry out practical learning activities from the theory that has been given. Its function is to support learning by increasing students' understanding of a material that has been studied. The existence of practicum activities in the laboratory will train students to develop the ability to experiment. Conducting experiments means training students to make careful observations, measure accurately with measuring instruments, handle and use tools safely, design, conduct, and interpret experiments (Hermawan et al., 2020; Ismail et al., 2016; Isozaki, 2017; Kim et al., 2019; Maeng et al., 2017; Orhan & Sahin, 2018; Pareek, 2019; Ping et al., 2020).

Problems in laboratory learning are problems that are of concern so that learning by doing as a student learning experience is also facilitated. Many researchers have carried out development and training related to supporting laboratory learning. Such as the development of practicum modules(Amirullah, 2018; Dinatha & Kua, 2019; Rohman & Lusiyana, 2017; Samsu et al., 2020), the development of virtual laboratories (Hermawan et al., 2020; Maeng et al., 2017; Wibowo et al., 2017; Wollmann & Lange-Schubert, 2022; Zabala & Dayaganon, 2023), the development practicum model (Dinatha & Kua, 2019; Grushow et al., 2022; Isozaki, 2017; Salabi, 2016; Seery, 2020; Supriyatman et al., 2018; Utami & Indriyanti, 2014). But the reality is different in the implementation stage. Based on observations of teachers and students of junior high school, they rarely practice. There are even students whose practical experience is the first time after becoming a student. The reasons given by the teacher The reasons for the lack of practical experience among students include the following: Firstly, tests that determine graduation are based solely on multiple-choice or essay exam scores, thus neglecting the practical aspect of learning. Secondly, the tight schedule and the rush to cover all the material leave no time for hands-on practice. Lastly, there is a shortage of necessary tools, and even when available, they are often inadequate. This research was conducted to examine science as a process by identifying the competence of science teachers in using the laboratory as a science process learning activity.

Method

This qualitative study, conducted from March to November 2022, describes the competence of science teachers in six public junior high schools in Palu City. Data were collected through laboratory observations, document reviews, and interviews. The study used a checklist and interview guide for data collection and content analysis for data evaluation. This qualitative research method emphasizes meaning rather than generalization (Sugiyono, 2011).

This research was carried out from March to November 2022 in six public junior high schools in Palu City. The six public junior high schools represent the population from a geographical perspective as shown in Figure 1.

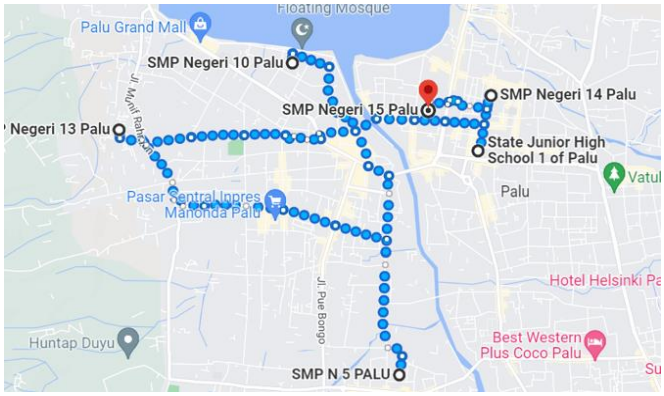


Figure 1. Research Locations (taken from (https://www.google.co.id/maps/)

The subjects of this study were also respondents, namely science teachers at SMP Negeri 1 Palu, SMP Negeri 5 Palu, SMP Negeri 10 Palu, SMP Negeri 13 Palu, SMP Negeri 14 Palu, and SMP Negeri 15 Palu.

Data collection was carried out in two stages, namely: In the initial phase, the research involved observing the laboratory settings to assess the completeness of management practices, the adequacy of equipment, and the presence of laboratory personnel. Following this, the second phase consisted of conducting interviews with science teachers to gather insights into their processes for planning, implementing, and evaluating laboratory

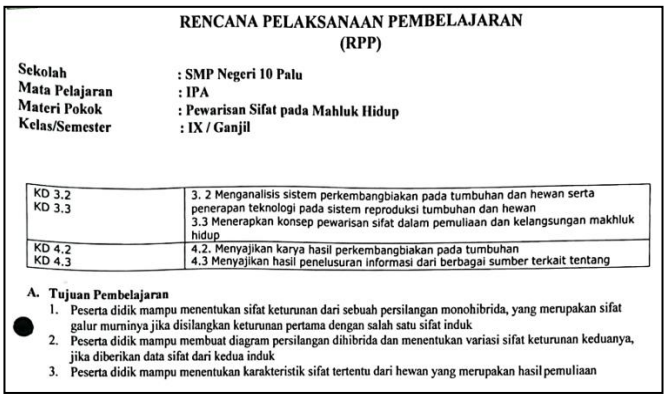
and field learning activities.

The research instrument used a checklist and an interview guide. The checklist is used as a guide for researchers to observe documents. Interview guidelines were used by researchers to collect information from respondents through verbal interaction. Data from observations and interviews were then evaluated using content analysis methods. The main purpose of content analysis is to discover the concepts and relationships that explain the data obtained. Content analysis methods are used to identify data, unite similar data within the framework of certain concepts and themes and uncover truths that may be hidden in the data. For this purpose, the raw data is encoded.

Result and Discussion

Result

Documents observed the documentation reviewed included several key elements: instructions for using the laboratory, guidelines for laboratory safety, lesson plans with a particular focus on lab and field learning, practicum modules and guidelines, and the implementation of laboratory learning activities. Documentation results are shown in Figure 2 (in Bahasa Indonesia), Figure 3, and Figure 4 below:



RENCANA PELAKSANAAN PEMBELAJARAN
(RPP)

Sekolah : SMP Negeri 10 Palu
Mata Pelajaran : IPA
Materi Pokok : Pewarisan Sifat pada Mahluk Hidup
Kelas/Semester : IX / Ganjil

KD 3.2 KD 3.3	3. 2 Menganalisis sistem perkembangbiakan pada tumbuhan dan hewan serta penerapan teknologi pada sistem reproduksi tumbuhan dan hewan 3.3 Menerapkan konsep pewarisan sifat dalam pemuliaan dan kelangsungan makhluk hidup
KD 4.2 KD 4.3	4.2. Menyajikan karya hasil perkembangbiakan pada tumbuhan 4.3 Menyajikan hasil penelusuran informasi dari berbagai sumber terkait tentang

A. Tujuan Pembelajaran
1. Peserta didik mampu menentukan sifat keturunan dari sebuah persilangan monohibrida, yang merupakan sifat galur murninya jika disilangkan keturunan pertama dengan salah satu sifat induk
2. Peserta didik mampu membuat diagram persilangan dihibrida dan menentukan variasi sifat keturunan keduanya, jika diberikan data sifat dari kedua induk
3. Peserta didik mampu menentukan karakteristik sifat tertentu dari hewan yang merupakan hasil pemuliaan

Figure 2. One of the action plan for laboratory learning by a science teacher

Figure 2 shows that the RPP prepared by the science teacher follows the 2013 Curriculum RPP format where KD skills and KD knowledge are in one lesson plan.

Figure 3. Laboratory learning activities carried out by science teachers

Figure 3 shows the activity of carrying out laboratory learning in one of the Public Middle Schools. It appears that the number of students in one group is quite large, up to eight students.

Figure 4. Science laboratory room management

Figure 4 shows the condition of the laboratory room in one of the Junior High Schools used for laboratory learning.

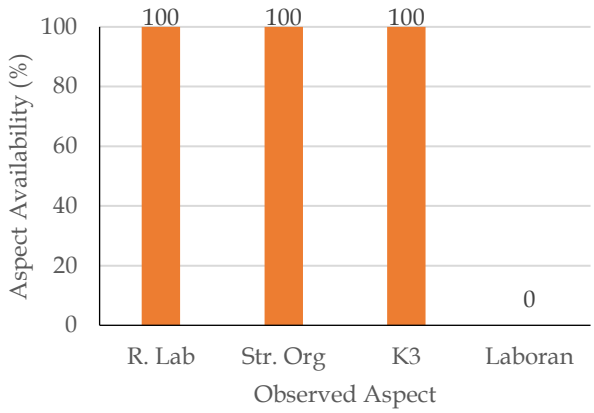


Figure 5. The results of evaluation data laboratory management

On the aspect of science teacher competence in laboratory learning, data collection was carried out through interviews. Coding is used to facilitate data processing and analysis. The coding for interview-related questions is the areas of focus included the significance of the laboratory in science education, teachers' experiences with conducting science learning in laboratory or field settings, their ability to identify basic competencies for lab or field learning, and the differences between lab learning and traditional classroom learning. Additionally, the development of lesson plans and practical instructions for lab learning, the use of virtual laboratories, the obstacles faced in implementing lab learning, mastery of all required practicums, and ensuring the correct execution of lab learning were also examined.

The results of data evaluation in the category of laboratory management are shown in Figure 6.

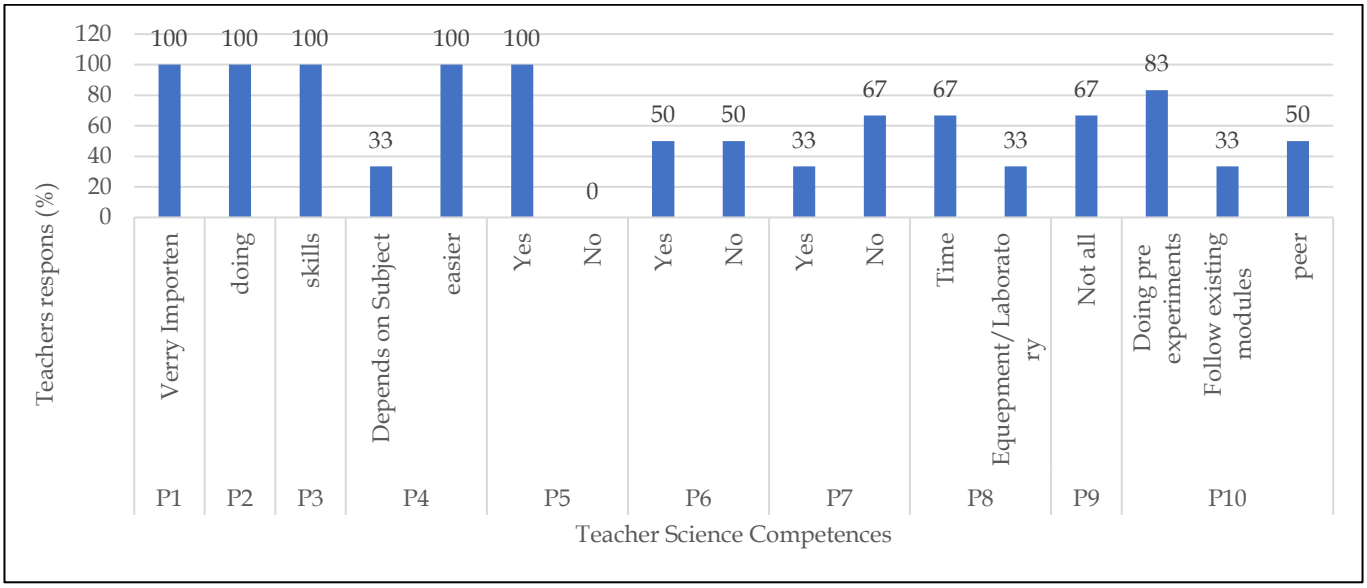


Figure 6. Science teacher's response diagram

Discussion

Science as a science essentially has three aspects, namely: attitude, process, and product. Therefore, science learning must also be based on these three aspects. Science learning that combines physics, biology, and chemistry is taught at the junior high school (SMP) level. So, teacher resources in junior high schools must master these three fields of knowledge.

Central Sulawesi, especially the city of Palu, still has many science teachers with undergraduate education backgrounds in physics, biology, and chemistry education. These different teacher competencies are a challenge for teachers, schools, and other stakeholders including universities in facilitating these needs. This research describes the condition of the SMP science laboratory as a place to teach science processes, and the competence of science teachers who manage the laboratory and learning.

Junior High school science laboratory conditions

The results of observations on the condition of the science laboratory in Palu City Junior High School were generally in good condition. All schools have a science laboratory room/building. This condition can be seen from the aspect of the adequacy of space, management, and availability of equipment.

Adequacy of room

The results of observations and interviews are shown in Figure 5. Even though they have laboratories, all schools complain that laboratory space is insufficient.Only one laboratory classroom for all classes ranging from 9 to 12 groups. While the demands of learning in the laboratory are in every basic competency (KD) that is charged from the curriculum. This condition is far from the standard area of a science laboratory where the minimum standard is 2 m2 per student for 28 students in each class.

Management

The management of the public junior high school laboratory in Palu City has been carried out well. This is shown in Figure 5 where there is a laboratory management organizational structure, there are rules of conduct, there are occupational health and safety (K3) guidelines, and the preparation and storage of equipment as shown in Figure 4. The implementation of laboratory management includes the effectiveness of using the laboratory, work safety, carrying out

regulations, and also procure tools and materials (Pujani & Selamet, 2020). The good management of the science laboratory is also reflected in laboratory activities that run smoothly according to their functions. This can be seen from the orderly use of the laboratory, the use of the laboratory for practicum, as well as the practicum implementation process (Pertiwi, 2019).

Equipment availability

The State Middle School Science Laboratory in Palu City, from the availability of some equipment, is sufficient. However, in some schools on the outskirts of the city, the equipment is not sufficient, especially consumables. This requires special attention from school principals and the city education office to allocate funds for the procurement of consumables. As stated by the following science teacher:

Teacher A: "…Complete equipment, insufficient space, and consumable materials need attention…"

Teacher B: "... First: the facility is repaired, secondly it is necessary to have a laboratory."

Teacher Science Competences

Based on the results of data processing from interviews with science teachers at State Middle Schools in Palu City, the competence of science teachers, in general, was in a good category. This is shown in Figure 6, where all schools carry out learning in the laboratory and the field. Science teacher competency in this case is competency in terms the focus was on three main aspects: lesson planning, the implementation of learning activities, and the assessment of learning outcomes.

lesson plan,

The science teacher at Palu City Public Middle School has carried out lesson planning well, namely by making a learning implementation plan (RPP) according to the 2013 curriculum format as shown in Figure 2. All teachers also understand that laboratory or field learning is in the context of fulfilling basic competency (KD) skills (Figure 6.) which is very important to do through practice. The following are excerpts from an interview with a science teacher:

Teacher A: "Because learning science requires practicum in student learning, from the book they will see the real and complete tools in the science lab that they need during practicum. Because some concepts have to be practiced in the lab so that children are brought here to see first-hand the medium or media such as a microscope can see an animal or plant cells or something else that is very helpful in the learning process. If in physics it is very important to prove the theory. even with simple equipment. So their students are directed to become researchers, small researchers who are very simple."

Teacher B: "...in the lab we teach rules, not just anything, want to handle tools, etc. If in class they are free, in the lab they are also free but bound."

Teacher C: "Yes, it's important because for materials that of course have to be done in the lab, even if the equipment is complete."

Teacher D: "It's very helpful because with the existing equipment it will be more contextual, children understand more, as a proof of concept."

Teacher E: "If you say it's important, it's very important if you make a percentage of 100% it's important. Many supports learning. You can learn in class, but it's a risk to bring lab equipment into class. Especially those made of glass that breaks easily."

Even though science teachers have backgrounds in physics education, biology education, and chemistry education, they do not give up when it comes to planning practicums. Through their colleagues, they help each other plan, design tools, and provide materials for a smooth and successful practicum. This result is in line with the peer supervision method carried out by Hadi (2019) who argues that peer supervision improves teacher performance (Hadi et al., 2019).

learning *implementation*

Science teachers at public junior high schools in Palu City have carried out laboratory and field studies by the action plan which is also adjusted to the characteristics of the material. Figure 3 shows the implementation of laboratory practices carried out by science teachers. In this implementation, the science teacher conducts a practicum using a practicum guide or module in the student book or an existing one from the IPA KIT. Some modify it according to teacher innovation and some just follow existing procedures. The following are excerpts from interviews with science teachers:

Teacher A: "No. Because it's already in the IPA kit."

Teacher B: "Just convey it"

Teacher C: "Practicum instructions are in the LKPD (made by the teacher)".

Teacher D: "Actually there is but a lack of PD (confidence) so asks for help from colleagues who can."

Figure 7. Electricity and magnet practicum module for junior high schools

This condition is in line with the results of research conducted by Ani Khoirotun Nisa (2019) that teachers tend to use textbooks provided by schools (Ani, 2022). The diagram in Figure 6 shows that the implementation of learning in the laboratory is completely carried out by the teacher without the help of a laboratory assistant. Supposedly a science laboratory has a laboratory assistant whose job is to help teachers carry out practicums from preparation to completion. State Middle School Science Laboratory in Palu City, no one has a laboratory assistant. So that teachers and colleagues help each other design, conduct trials, and even to implementation. This condition makes teachers prefer to carry out practicum activities by conducting demonstrations in class. The following are excerpts from interviews with science teachers:

Teacher: "...With the current conditions of the lab, yes, the equipment is brought to class for a demonstration/ demonstration."

1) Learning outcome assessment.

The assessment carried out by the teacher uses a skills assessment instrument that has been compiled and integrated with the preparation of the lesson plan, shown in Figure 8.

	Kegiatan Penutup (15 Menit)
Peserta Didik	Siswa melakukan refleksi tentang pelaksanaan pembelajaran dan pelajaran apa yg di peroleh setelah belajar tentang topic. Membuat ringkasan dengan bimbingan guru tentang hal-hal penting yang muncul dalam kegiatan pembelajaran yg baru di lakukan.
Guru	Melakukan penilaian. Memberi tugas kepada peserta didik (PR) dan mengigatkan untuk mempelajari yang akan di bahas di pertemuan berikutnya maupun mempersiapkan diri menghadapi tes/ evaluasi akhir di pertemuan berikutnya. Menutup kegiatan belajar mengajar dengan berdoa.

D. **Penilaian Hasil Pembelajaran**
1. Penilaian Pengetahuan; Teknik Penilaian: Tes Uraian
2. Penilaian Keterampilan; Penilaian Praktek

Palu..... Juli 2022

Mengetahui,
Kepala Sekolah

Hj. Ramlah M.Siri, S.Pd, M. Si
NIP.19650212 198601 2 004

Guru Mata Pelajaran

Andi Mirnasa S.Pd
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Figure 8. Forms of skills assessment in lesson plans

The results of observations on the implementation of the skills assessment were only shown in the form of the assessment as stated in the lesson plan and the teacher did not show the assessment instruments and rubrics.

Conclusion

The study examined various aspects of laboratory learning in junior high schools, including lesson planning, the implementation of learning activities, and the assessment of learning outcomes. The research found that most schools had incomplete science laboratories in terms of buildings, equipment, and personnel. Despite these challenges, science teachers demonstrated competency in planning and implementing laboratory-based learning. However, there is a need for improvement, particularly in preparing practicum guides, conducting experiments, and developing effective skills assessment methods. The study suggests that further research should explore the impact of science teacher competence on student learning outcomes, focusing on the forms and techniques of assessment and the results of student skill competencies.

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Author Contribution
SS: Conceptualization, Methodology, Data Collection, Data Analysis, Writing - Original Draft, Supervision. AK: Conceptualization, Methodology, Data Collection, Writing - Review & Editing. IWD: Methodology, Data Collection, Writing - Review & Editing. MM: Data Collection, Writing - Review & Editing. SS: Conceptualization, Writing - Review & Editing, Supervision. II: Data Collection, Writing - Review & Editing, Funding Acquisition.

Conflict of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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