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Challenges and Alternative Solutions for Implementing Chemistry Practicums in Public High Schools

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Abstract

Laboratories play a crucial role in enhancing learning experiences, verifying scientific concepts, and solving problems through scientific methods. However, the implementation of chemistry practicums in schools often faces significant challenges. This study aims to identify the problems hindering the implementation of chemistry practicums and propose alternative solutions to address these issues. A survey method was conducted using a qualitative descriptive approach. The population consisted of 45 schools in Aceh, involving 981 grade XII students. A cluster sampling technique selected 13 schools, comprising 80 participants, including principals, chemistry teachers, and students. Data were collected through validated instruments, including observation sheets, response questionnaires, interviews, and documentation. The findings revealed several obstacles, including inadequate laboratory infrastructure, unprepared teachers, insufficient tools and materials, limited supporting facilities, and a lack of laboratory staff. To overcome these challenges, alternative solutions were suggested, such as conducting practicums in classrooms through demonstrations, utilizing natural materials and virtual media, aligning practicums with learning standards, adopting blended learning models, and recruiting laboratory staff. These proposed solutions provide practical approaches to improving chemistry practicum implementation in public high schools, ensuring students gain hands-on learning experiences and enhancing their understanding of scientific concepts.

Keywords: chemistry education, laboratory, practicum

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1. Introduction

A laboratory, often referred to as a "lab," is a place where scientific research, experiments, measurements, and scientific training are carried out. According to the Ministry of National Education, a laboratory is a place to apply scientific theory, test hypotheses, validate experiments, and conduct research using tools that serve as facilities to complete practical activities (Indrawan et al., 2020). Furthermore, it is also a place for the development of knowledge (Pawlicka-Deger, 2020).

Practical work is essential in achieving chemistry learning goals (Inayah et al., 2020). Students engage in gaining insight and discussing problem-solving strategies with group members. Indirectly, behavioral changes in cognitive, psychomotor, and affective aspects emerge as natural outcomes,

contributing to the development of logical and systematic thinking (Rahman et al., 2020). Students play a crucial role in understanding the material, aiming to develop a scientific mindset, achieve the required grades, and grasp the essence of the subject matter (Darmaji et al., 2019; Puspita et al., 2021). The learning process, by applying a practical model, provides opportunities for students to actively engage, experience, and validate the knowledge they have acquired, fostering motivation, interest, and process skills (Ardiansyah et al., 2023).

Chemistry is one of the subjects within the scope of science. The abstract and challenging nature of chemical material makes it inseparable from the laboratory (Merta, 2021). Laboratories play a crucial role in developing conceptual understanding, inquiry skills, scientific perception, and cognitive growth (Elbayoumi, 2020; Grushow et al., 2021). Therefore, learning activities are often conducted through experiments to enhance students' skills in using various equipment. Experimental activities guide students to develop directed and systematic skills based on concrete, collaborative, reflective, and interpretive experiences (Agustian et al., 2022). Currently, chemistry practicals are rarely conducted in several schools due to incomplete laboratory facilities (Jahro et al., 2021; Osman & Lay, 2022; Prajoko et al., 2017).

Through experiments, students not only acquire experimental techniques but also deepen their understanding of concepts. Teachers are responsible for ensuring the availability of practical materials, maintaining work safety, and supervising the proper use of tools and chemicals both inside and outside the laboratory (Elbayoumi, 2020; Grushow et al., 2021). Practical activities enhance students' process skills, which include observing, questioning, predicting, planning, conducting investigations, processing and analyzing data, evaluating and reflecting, and communicating results (Ardiansyah et al., 2023). However, implementing experiments in classrooms remains problematic due to a lack of laboratory facilities, making the experimental process ineffective.

Success in carrying out practical activities relies on the availability of complete laboratory facilities, such as proper storage space, chemical equipment, and conducive rooms (Namira et al., 2020). Schools with dedicated chemistry laboratories are essential to accommodate large numbers of students and store substantial amounts of equipment and materials without disruptions (McHugh et al., 2024). Additionally, spatial planning is critical to minimize accidents during experiments, facilitate supervision, and optimize the use of tools and materials (Gusnani et al., 2019).

The availability of facilities and infrastructure supports practical activities; however, practicals are sometimes delayed, leading to problems such as practical topics not being conducted due to the limited availability of tools and materials, which are often quite expensive (Asmaningrum et al., 2018; Harta et al., 2019). The management of tools and materials for practical activities in schools has also not been carried out properly. Not all materials for practicals are implemented according to the initial plans made by the teacher, which impacts the timing of practical activities (Damayanti et al., 2019). In line with the research of Mardhiya and Laila (2022), it has been explained that issues in conducting practical activities stem from the unavailability of chemical equipment, limited time, and poor laboratory management. These challenges often arise due to the lack of follow-up from schools regarding the facilities required by teachers to conduct experiments. As a result of these limitations, teachers have resorted to creating practical activities using simple tools and materials that are easy to find in the environment.

Determining the tools and materials to be provided in the laboratory requires collaboration between teachers and laboratory assistants. Each hands-on activity requires tools with specific completeness and specifications. The tools used must align with the practical needs, including basic tools, demonstration tools, support tools, and fire extinguishers. Teachers and laboratory assistants also prepare procedures for

borrowing tools and materials (Subamia et al., 2015; Wibowo, 2015).

Based on a field study conducted in one of the SMAN schools in Aceh, the chemistry laboratory has not been used for a long time, and there has been no follow-up from the school to renovate it. In the materials room, there are chemicals that have leaked, evaporated, expired, or have unclear label information. Chemicals that are no longer suitable for use have not been disposed of and remain abandoned. Discussions with teachers and laboratory managers revealed that the laboratory has been inactive since the Covid-19 pandemic. It is considered unsuitable for use because hazardous materials pose risks to both the school environment and the community. Furthermore, the completeness of facilities and infrastructure remains constrained by the lack of support and assistance from the local government.

Other studies have also identified several problems in school laboratories, including incomplete chemical practicum equipment and insufficient time for practicum implementation, which demotivates teachers from conducting experiments (Rahman et al., 2020). Similar issues were reported in other research, such as the lack of available tools and chemicals, infrequent inventory of tools and materials (often only conducted during agency data collection), and the absence of laboratory assistants and technicians. Expired materials are often stored alongside other practical tools, further compounding the issue (Siregar et al., 2023).

Several other studies also highlight that laboratory facilities and infrastructure greatly support the quality of learning, both mobile and non-mobile, enabling laboratory objectives to be achieved in an orderly, effective, and efficient manner. The availability of equipment and materials needs careful consideration, including selection, procurement, needs analysis, prioritization, accuracy, and budget alignment. One problem identified is that the equipment is often incomplete and does not meet the standards for facilities and infrastructure management due to limited funding and insufficient administrative staff, resulting in infrequent laboratory inventories (Sabudu et al., 2021). Additionally, practical activities have not been carried out effectively because laboratories are often used as study rooms, and the absence of laboratory staff leads to poor management of tools and materials. Therefore, this study is important to identify the problems faced by schools regarding the causes and effects of not implementing chemistry practicums (Namira et al., 2020).

Based on the problems above, it is necessary to collect data from several schools regarding the implementation of chemistry practicums, focusing on the constraints, barriers, and alternative solutions to the challenges faced by SMAN in Banda Aceh and Aceh Besar. The research aims to identify the factors hindering the implementation of practicum activities and propose solutions to address these issues.

2. Research Method

The research methods used are the survey method and literature review. The survey method was conducted to obtain and collect natural data from schools regarding the completeness of infrastructure, constraints, obstacles, and the implementation of chemistry laboratories (Sugiyono, 2018). The survey results on constraints and obstacles were obtained through laboratory observations and responses from chemistry teachers, students, and principals. The literature review was employed to identify alternative solutions and actions aimed at ensuring the survey results are accurate, reliable, and precise (Snyder, 2019).

The research was conducted in state high schools in Banda Aceh and Aceh Besar with laboratory infrastructure, involving 45 schools and 981 survey participants from class XII students. The population comprised 17 state high schools in Banda Aceh and 28 schools in Aceh Besar. The sampling method used was a probability sampling technique, specifically the cluster sampling type (area sampling), which is suitable for a very large population.

Given the stratified nature of the population, proportionate stratified random sampling was applied to account for its heterogeneity (Sugiyono, 2018). The samples obtained consisted of six schools from Banda Aceh and seven schools from Aceh Besar, resulting in a total of 13 sample schools.

The student sample was selected using the same technique, resulting in six students per school, out of 80 surveyed participants. This figure was derived from 30% of the sample schools with the same accreditation, ensuring representativeness of the participants (Arikunto, 2006). Principals and teachers were selected using non-probability sampling techniques, specifically the purposive sampling method, to include key informants with relevant roles and expertise. The selection of 13 principals was based on their responsibilities in managing school facilities, while 13 teachers were chosen for their knowledge and experience in conducting chemistry practicums, as guided by the curriculum. In total, there were 106 survey participants: 13 principals, 13 teachers, and 80 students (Sugiyono, 2018). The instruments used included laboratory observation sheets, response questionnaires, interviews, and documentation, designed to provide comprehensive insights into laboratory facilities and practices.

The observation sheets focused on furniture, equipment, educational media, other tools, and consumables, ensuring compliance with national education standards. These standards serve as benchmarks to evaluate the adequacy and functionality of laboratory facilities in supporting learning. Observations were conducted directly in school laboratories to gather accurate data on their condition. Questionnaires were distributed to six Class XII students and one subject teacher per school, capturing perspectives on facilities, curriculum alignment, and practicum implementation (Masruri, 2020; Rahman et al., 2015). Data from the questionnaires and observations were analyzed using inferential statistics to calculate the average percentage, providing a basis for general conclusions about the state of laboratory facilities and their adherence to standards.

Direct interviews were conducted to explore the issues in greater depth. The interviewees included 13 principals and 13 subject teachers, and their responses were recorded and transcribed to strengthen the collected data. Qualitative data analysis involved data reduction, data display, drawing conclusions, and validating them (Sugiyono, 2018). Finally, documentation supported the data collection process, utilizing tools such as cameras to produce photos and videos deemed relevant.

3. Results and Discussion

3.1. Laboratory Observation

Observations at several schools revealed that not all met the required laboratory building standards. According to the High School Building and Furnishing Standards, a chemistry laboratory should have a total area of 15 x 8 m^2, with a minimum space allocation of 2.4 m^2 per student, and should include both a preparation room and a practicum activity room (Aswadi, 2014). The observation categories were based on *standar nasional pendidikan* (SNP) or national education standards, which set minimum criteria for Indonesia's education system, including facilities and infrastructure standards. These standards cover furniture, educational equipment, educational media, other tools, and consumables. While several schools provided preparation spaces for tools and materials, three schools used almost their entire laboratory space exclusively for practicum activities, and some lacked complete practical equipment (Rahman et al., 2020).

As shown in Table 1, many laboratories had movable worktables that were not equipped with sinks or water facilities, posing challenges for water-intensive activities. According to discussions with a school principal, it was noted that not all facilities are adequate, with many requiring significant improvements. While some schools are still striving to meet the minimum standards, others are making

efforts to fully comply with or even exceed these requirements. This variability reflects the ongoing challenges and progress in achieving uniform laboratory standards across schools in Indonesia.

Table 1. Condition of Laboratory Facilities

No	School	Type Laboratory	Room Lab	Information
1	S-1	Natural Science	Natural Science	Meet the SNP
2	S-2	Natural Science	Chemistry	Very Satisfying SNP
3	S-3	Natural Science	Chemistry	Just Meet the SNP
4	S-4	Natural Science	Chemistry	Just Meet the SNP
5	S-5	-	-	Does Not Meet SNP
6	S-6	Natural Science	Natural Science	Just Meet the SNP
7	S-7	Natural Science	Natural Science	Just Meet the SNP
8	S-8	Natural Science	Natural Science	Less than SNP Compliant
9	S-9	Natural Science	Natural Science	Does Not Meet SNP
10	S-10	Natural Science	Chemistry	Less than SNP Compliant
11	S-11	Natural Science	Chemistry	Does Not Meet SNP
12	S-12	Natural Science	Natural Science	Less than SNP Compliant
13	S-13	Natural Science	Chemistry	Just Meet the SNP

The condition of equipment and materials from the chemical laboratory survey results includes furniture, educational equipment, educational media, other equipment, and consumables, then we obtained a school that meets the standards with a score of 100% from S-2 Banda Aceh. The category meets the standards with a score of 83% obtained by S-1 Banda Aceh. There were five schools in the category that meet the standards, three schools in the category that did not meet the standards, and three schools that did not not meet the standards for implementing chemistry practicum. The percentage of availability of tools and materials can be seen in Figure 1.

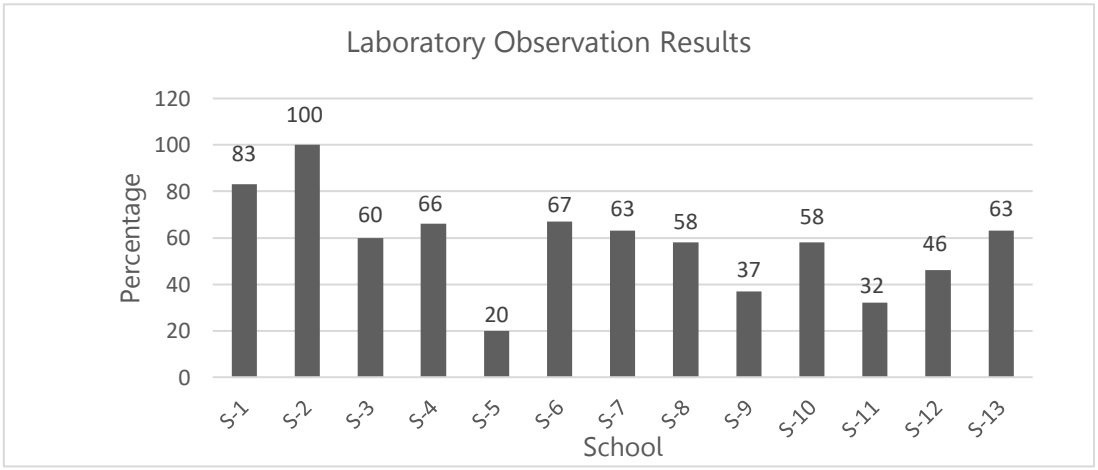

Figure 1. Percentage of Availability of Laboratory Equipment and Materials

Based on the Figure 1, the ratio and description of the amount of furniture in the laboratory consisting of chairs, worktables, demonstration tables, preparation tables, work chairs, tool cupboards, materials cupboards, fume cupboards, sinks and other furniture is still below standard the ratio is determined based on SNP, for example in undergraduate schools S-1 there were one tool and materials cupboard with three doors made of iron and not sliding doors. The materials were in cupboard 1 and the rest contain tools. The cupboard for materials was also in the cupboard under the sink. At the S-10 school, there were two cupboards made of wood in which there were other chemical

materials and tools. Spilled or leaked material has not been removed, so the solution was absorbed by the wood. The calculation of the number of furniture ratios is carried out by comparing the number of ratios that should be with those available, to obtain percentage results of 83% and 58%. It is necessary to detail the components contained in the laboratory, such as spatial layout, calibrated equipment, laboratory management infrastructure, inventory, security, safety measures, laboratory organization, funding, level of discipline, user skills, basic rules, and problem handling (Nisa et al., 2021). These components can run well if there is systematic laboratory management.

From 13 schools, results were obtained which could be concluded to be a problem, specifically that laboratory conditions were not entirely adequate. These findings have become the main problem in carrying out practicums at every school and are the main root of various obstacles that will arise, such as the condition of chemistry laboratories because not all schools have special chemistry laboratories due to the lack of land to build laboratory space. The use of classrooms has become a target for creating chemistry laboratories due to lack of funds to facilitate laboratories. Similarly, research by Taharu & Aba (2020), shows that not all schools have chemistry laboratories, and that laboratory facilities especially buildings or laboratory space are the biggest obstacles to conducting practicums.

3.2. Teachers' Responses of Questionnaire

Problems that often occur during the learning process become a reference for teachers in finding solutions to every problem. The detailed questions regarding the implementation of closed chemistry practicums aim to make it easier to obtain answers quickly. The aspects reviewed from the response questionnaire are facilities, curriculum, and implementation. The overall results of each question from the entire sample of 13 chemistry teachers who obtained answers to determine the effectiveness of implementing chemistry practicum, can be seen in Table 2.

Table 2. Chemistry Teacher Responses

No	Rated Aspect	%	Criteria
1	Chemical laboratory conditions	62	Effective enough
2	Practical tools	31	Ineffective
3	Practical chemicals	31	Ineffective
4	Supporting facilities, such as water/gas/ventilation	69	Effective enough
5	Time Allocation	85	Effective
6	Practical role	46	Less effective
7	Availability of laboratory staff	15	Ineffective
8	Prepare tools and materials by laboratory staff	15	Ineffective
9	Create practical work instructions	100	Very effective
10	Difficulty when preparing for practicum	15	Ineffective
11	Another alternative is implementing practical activities	100	Very effective
12	Practical worksheet	100	Very effective

Based on Table 2, various problems were found which became constrains, obstacles, and alternative solutions to the implementation of chemistry practicum in all sample schools. The results obtained were that tools and chemicals were not available in their entirety, laboratory staff were not available, facilities were not functioning properly, and difficulties in preparing the practicum obtained the criteria for not being effective in carrying out the practicum, because there were several requirements for the practicum that were not available and possible to carry out, make it becomes an obstacle during experimentation.

The problem of unavailable tools and materials is an obstacle that serves as a benchmark for teachers in deciding whether to continue the practicum. On average, the

equipment available is a grant from the Department of Education, but the ratio and volume provided are not suitable for chemistry practicum purposes in schools. However, the impact on student learning outcomes shows that high or low utilization of laboratory equipment does not affect student achievement (Van Harling & Tobi, 2019). For example, a measuring cup has a volume of 1000 mL with a ratio of 10-15 pieces. According to SNP, the ratio of measuring cups is 3 for a volume of 1000 mL. Tools available in large sizes are usually not used for practicums and do not use large amounts of materials, so it is a waste of the tools that have been given. Several practical tools that are not yet available by SNP, include beakers, volumetric flasks, test tubes, thermometers, and barometers (Rahman et al., 2020).

The next obstacle was that there are no laboratory assistants for chemistry laboratories and other laboratories. The school has assigned the laboratory management to the laboratory head and subject teachers. Teachers provide all the practicum needs before and after the practicum, so that some teachers prefer to carry out simple practicums with materials that are easily found in the natural surroundings. School laboratory personnel standards have been regulated in SNP, including laboratory heads, laboratory technicians, and laboratory assistants. The availability of laboratory assistant vacancies has also not received further information from the Department regarding the procurement of laboratory assistants, the school is also not recruiting laboratory assistants due to lack of funds to pay for laboratory assistants. Schools only have laboratory heads who serve as laboratory personnel and of course this does not meet laboratory personnel standards, so that laboratory managers become less effective if teachers and laboratory managers must perform some of the laboratory assistant's tasks (Kurniawan, 2021).

Other facilities were also inadequate, such as the clean water supply in the laboratory room. Water is essential during practical activities for washing tools, preparing solutions, and maintaining cleanliness, but not all schools have adequate water availability. This lack of clean water significantly hampers the efficiency and safety of chemistry practicals. Additionally, the air ventilation in the chemistry laboratory must be sufficient, as the laboratory frequently uses volatile and potentially hazardous chemicals. Poor ventilation could pose health risks to students and teachers, emphasizing the need for compliance with safety standards. Other research also discusses laboratory facilities, stating that chemical laboratory facilities are divided into two categories: general and special. General facilities are shared by all laboratory users and include water, sinks, electricity, and gas, which are crucial for basic operations. On the other hand, special facilities refer to resources specifically allocated for tools, materials, and equipment unique to chemistry experiments, highlighting the need for tailored infrastructure to support specialized activities (Van Harling & Tobi, 2019).

The results obtained showed that high or low utilization of laboratory facilities does not affect student learning achievement. Furthermore, the difficulty in preparing practicums is an obstacle for teachers who not only teach but are also involved in providing equipment and materials before and after carrying out practicums. It does not rule out the possibility of teachers who hold concurrent positions as laboratory assistants carrying out practicum activities, ensuring that the practicum continues as original planned in the learning implementation plan. That the management of laboratory tasks is the responsibility of a teacher who has concurrent duties other than teaching. Chemistry teachers assigned the task of managing laboratories need to be trained in laboratory management and administration by attending workshops organized by universities or other organizations (Burhanuddin et al., 2022).

3.3. Students' Responses of Questionnaire

Problem collection was continued by providing response questionnaire sheets to 39 class XII students from the entire research sample. The aspects reviewed are the same as

the chemistry teacher response questionnaire, but the number of questions is different. There are 13 questions that will be given with the aim of seeing students' responses to the implementation of chemistry practicum while at school. The results of all questions can be seen in Table 3.

Table 3. Student Responses

No	Inquiries	%	Criteria
1	Chemical laboratory conditions	82	Effective
2	Practical chemicals	45	Less effective
3	Availability of practical tools and materials	61	Effective enough
4	Use of tools and other practical material	95	Very effective
5	Supporting facilities (water/gas/ventilation)	92	Very effective
6	Time allocation	82	Effective
7	Difficulty participating in practical activities	21	Ineffective
8	Difficulties during practicum	97	Very effective
9	Laboratory readiness	76	Effective
10	Teacher rediness	100	Very effective
11	Often uses practical methods	76	Effective
12	Alternative practical implementation	89	Very effective
13	Practical worksheet	29	Ineffective

Based on Table 3, similar to the responses from chemistry teachers, students identified several issues in implementing chemistry practicums, including the lack of necessary chemicals (45% answered "Yes"), incomplete availability of tools and materials (61%), difficulties in conducting practicums (21%), and laboratory staff preparing materials before practicums (76%). Teachers with dual roles, including teaching and laboratory management, require training in laboratory management and administration, which can be obtained through workshops organized by universities or MGMP organizations (Burhanuddin et al., 2022). The role of laboratory staff is thus critical to the success of laboratory activities, as teachers face challenges not only in infrastructure but also in conducting practicums effectively.

In some schools, there are no laboratory assistants available, and everything must be prepared solely by the teacher, who consequently assumes the dual role of both teacher and laboratory assistant. In schools where only a laboratory head serves as laboratory personnel, this limited staffing arrangement significantly fails to meet the essential standards required for laboratory operations. Consequently, laboratory management becomes increasingly less effective and inefficient when teachers and laboratory heads are burdened with performing multiple overlapping roles, leading to decreased productivity and potential compromises in the quality of laboratory work. (Kurniawan, 2021).

3.4. Principal's Responses

Various observational evidence and findings regarding the implementation of chemistry practicum from teacher and student response, questionnaires were further strengthened by interviews with school principals from 13 samples. The overall results of an interview of 13 school principals, can be seen Tabel 4.

According to several school principals, not all schools have chemistry laboratories with standard tools and materials, because they do not have the funds and land to build a laboratory. Supporting facilities are also inadequate, because there are areas where clean water is difficult to obtain. Additionally, the budget for laboratories comes from *bantuan operasional sekolah* (BOS) or school operational assistance contributions, which are used for all school needs, not just laboratories, so BOS funds are allocated differently to each school.

Table 4. Principal's Interview

No	Quentioner (Question)	Principal's (Answer)
1	Does your school have a chemistry laboratory?	Some schools have chemistry laboratories, but they are combined with physics and biology laboratories. There are no dedicated chemistry laboratories due to the limitations in laboratory facilities, which are not yet up to standard.
2	How is the chemistry laboratory at your school?	If the high school level has met the standards, the tools are not the latest, only the materials are still lacking. In fact, the combined laboratory actually does not meet the requirements, but in terms of practice, there are no obstacles. We set put the tools separately.
3	In your opinion, are the chemistry laboratory facilities adequate for carrying out practical work?	For the minimum standard, although not 100% sufficient. Actually the tools are available but we are limited by human resources. It is not impossible, maybe not so common. Extraction and distillation media may not be frequent, even if the tools are not used.
4	Does your school have special funds/budget for laboratory maintenance?	If there is no special fund for maintenance, it is included in the BOS fund. In fact, it is indeed budgeted every year from the BOS fund, although it is insufficient, but it exists. The BOS fund is also limited to its allocation according to the report on the quality of school education.
5	Are there special funds/budgets for providing laboratory facilities?	Yes, we can budget based on the percentage distribution, so it can't be perfect, it can be gradual. So, include in BOS funds. BOS is for school operations.
6	Has the laboratory ever been stopped due to problems with providing practical materials?	Nothing, we just have to keep going as best we can. There is still a shortage of materials, we just put in the archive budget or work around it if it is small things like using natural materials.
7	Does your school provide laboratory assistants to take care of the laboratory?	The government has never opened a position for laboratory assistants. The school needs to have laboratory staff, but it has never been opened. That is the obstacle in terms of getting laboratory staff.
8	Do you often monitor the implementation of practical work in the laboratory?	According to the schedule, there are representatives who best understand what we are sending out, we also monitor the implementation, availability, room conditions and facilities. But in order to monitor the process of the intership in the classroom, there are senior teachers in certain areas who are directed there, including the school director.
9	According to your observations, do teachers often do practical work in the laboratory?	In accordance with the material and teaching module.
10	Have you ever been assigned a teacher/laboratory manager to take laboratory management training	Yes, there are activities that we send to different areas of study. We are invited, there are teachers who are looking for us to let them in. But all the time, the education department has created our foundations where we have sent them.

3.5. Alternative Solutions to Practicum Implementation

Alternative solutions were obtained to find other ways and techniques for carrying out practicums which could not only be carried out in the laboratory but also in school, classroom and field settings which made it possible to provide education regarding a practical activity. The solution offered by the teacher for chemistry practicum if the availability of materials is insufficient or not available is that the teacher uses natural materials from the environment around the school or can be brought from their respective homes. Not only that, when practicum cannot be done in the laboratory, the teacher directs

students to do it in class by demonstrating and showing practicum-based learning videos. The solution offered is that the lack of tools and materials can be replaced by holding demonstrations in class (Nuswowati et al., 2020).

The problem of laboratory conditions in schools is that not all have special chemistry laboratories and there is not even room for a laboratory. The laboratory is also used as a seminar room for scientific papers, meetings, and a place for students to worship because the prayer room is currently under renovation. The solution offered is that the laboratory functions as a classroom, storage place for all school facilities, meeting rooms, and national assessment exam rooms with very limited quantities and types of chemicals, so that practical implementation is carried out inside. class by bringing all the necessary materials and equipment under the supervision of the subject teacher (Ardiansyah et al., 2023).

Teachers facing significant challenges in preparing practicums can address this issue by focusing on their crucial role as designers and facilitators of effective and efficient practicum activities. They must ensure that these activities provide meaningful, engaging experiences while aligning with established learning standards and catering to diverse student needs (Keliata & Choirunnisa, 2023). The blended learning model offers an innovative solution, enabling students to independently explore and understand practicum materials through teacher-prepared videos, images, and other digital resources outside of school hours, which significantly helps boost learning motivation and enhances overall student engagement (Arifin & Abduh, 2021).

The lack of chemical supplies in schools is an obstacle for teachers in carrying out practicums. It often happens that practical work is not carried out because the required materials are not available or have expired. The solution offered is that apart from the materials available in the laboratory, teachers can use materials found in the surrounding environment so that practicums can be carried out easily (Yusmarina et al., 2021). Another solution, if the practicum cannot be carried out due to certain obstacles, it can be replaced by using virtual laboratory media (Masruri, 2020).

The problems regarding laboratory personnel must be in accordance with the laboratory personnel qualification standards that have been set. The solution offered is by communicating between the school principal and the committee for planning the procurement of laboratory staff and if the school has financial constraints, it can provide facilities for teachers to take part in laboratory management training in the form of seminars or special training, thereby improving insight for teachers (Kurniawan, 2021).

4. Conclusion

The result obtained from several schools regarding obstacles, barriers, and solutions to problems in the implementation of chemistry practicums, conclude that several schools do not yet have a dedicated chemistry laboratory with a score of 62% and 82% due to a lack of land and funds. Another obstacle is the willingness of teachers to prepare practicum tools and materials with a score of 31% and 45%. Teachers are not only tasked with teaching but are also responsible for preparing tools and materials before and after the implementation of practicums. Further challenges include the availability of tools and materials a score of 61% with ratios and volumes that are not yet suitable for the needs of chemistry practicums in schools. Additional obstacles involve inadequate facilities with a score of 69% and 92%, such as the lack of clean water in the laboratory rooms, and the absence of laboratory assistants, which place the burden of laboratory tasks on laboratory supervisors and subject teachers. To address these problems, an alternative solution is to conduct practicums in classrooms through demonstrations, utilizing natural material and virtual media, preparing practicum aligned with learning standards, implementing blended learning models, and planning for recruitment of laboratory staff.

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