

Analysis of Chemistry Lab Readiness for Practice in High School:

A Case Study

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Abstract—This study aims to determine the readiness of the laboratory in the implementation of the chemistry practicum. This research is a descriptive research, with survey method. Research using the techniques of data collection via the question form, observation, and interviews. Data analysis technique used is descriptive. This research was conducted in 5 schools in Langsa City which have laboratories. The results of this study found that the readiness of the chemical laboratory at the school of the samples were in accordance with the standards appropriate infrastructure that mention in government regulations. However, the frequency of execution of practical chemistry was still classified as low. Implementation of practical chemical in sample school is quite well. The main factors that become an obstacle in the implementation of practical chemistry are was not available the allocation time of implementation, lack of power manager laboratories and the availability of chemicals.

Keywords—chemistry, laboratory, practicum, high school, readiness

I. INTRODUCTION

Practicum is a form of teaching and learning that aim to strengthen mastery of applicable material. Through independent and guided activities, and optimal utilization of practicum facilities as a whole in the practicum implementation system, it is hoped that they can achieve their learning objectives well [1]. The biggest inhibiting factor for practicum is less time. The effectiveness of laboratory use on learning outcomes has significant implications [2].

Laboratory has a special and central role in science curriculum and science educators, many of the benefits derived from student activities in science laboratories [3]. Meanwhile, chemistry must be taught in the laboratory [4]. In the Law of

the Republic of Indonesia Number 20 in 2003 concerning the National Education System, it is explained that the laboratory is one of the sources of chemistry learning which is indispensable to provide real experiences to students, as one of the supporting factors for learning. The existence of a chemical laboratory in high schools is a necessity in modern science education. The use of chemistry laboratories in learning will provide direct experience to develop competencies to be able to explore and understand the natural surroundings scientifically and will provide experience to be able to propose and test hypotheses through experiments, design and assemble experimental instruments, collect, process, and interpret data, compile reports, as well as communicating the results of the experiment orally and in writing. So, it is necessary to provide practical tools and materials and good laboratory management, so that the implementation of chemistry learning can run optimally. With a laboratory it is hoped that the science teaching process can be carried out as optimally as possible, although that does not mean that science cannot be taught without a laboratory [5].

Chemical laboratories at high schools are fully managed by the schools concerned. In the Regulation of the Minister of National Education of the Republic of Indonesia Number 24 of 2007 concerning the standard of facilities and infrastructure for high schools, stipulates that every education unit, especially high schools must have several aspects, especially a laboratory. Referring to the government regulations, ideally every high schools has a science/chemistry laboratory that can be maximized for learning activities. However, in reality, there are still schools/madrasahs that do not yet have adequate facilities in laboratories, so this is an obstacle in implementing practicum in high schools. In addition, if a high school already

has a laboratory, the equipment and chemicals in the laboratory have not been used optimally.

The laboratory is a place to train students' skills in practicing demonstrations, experiments and developing science. In addition, laboratories have a very important role in science learning in schools because laboratory activities are expected to foster student interest in laboratory activities [6]. Both science laboratories and chemical laboratories must be designed and built according to standard criteria that consider elements of health, safety, regulations that aim to make laboratories able to provide optimal benefits with minimal risks [7]. Likewise, to support the learning process, the laboratory must be managed by competent school laboratory personnel, complete equipment, and good management. There are laboratory personnel such as laboratory chairmen, laboratory assistants, technicians and subject teachers who have competence in laboratory management [8]. In a research's results state, there is an influence of laboratory contributions on critical thinking skills and chemical creative thinking skills. In addition, there is an influence of attitude towards laboratory use, critical thinking skills and chemical creative thinking skills [9].

The laboratory is part of a chemist's identity [10]. The chemistry lab is crucial for developing student engagement and learning with hands-on, relevant experiments in a socially dynamic classroom setting [11]. Furthermore, the issues arise in performing laboratory hands-on activity are: the less frequency in its implementation, the lack of students' interest, the limited in time, and lack of preparation [12]. Based on observations, it is known that most laboratory tools and materials are kept neat and never used. Based on the results of an interview with one of the high school chemistry teachers, information was obtained that practicum could not be done every semester due to limited chemicals in the high school laboratory. Seeing this alarming condition, one action is needed to determine the problem and the cause of this situation. Therefore, research is needed to find out how the readiness of the laboratory is in the implementation of chemistry practicum in high school. This study aims to determine the readiness of the laboratory in the implementation of the chemistry practicum, the readiness of the aspects of facilities and infrastructure as well as laboratory personnel.

II. METHODS

This type of research is descriptive research. Descriptive is research that describes a phenomenon that occurs in the object of research. The method used in this research is a survey method. The variable measured in this study was the laboratory readiness variable. The population of this study were all high school chemistry teachers in Langsa City. The sample in this study was taken by purposive sampling. As for the research

samples were all chemistry subject teachers and laboratory assistants in SMA Negeri Langsa City.

The activities carried out during the research, namely; a) Observation of laboratory conditions, observations made include observations of laboratory conditions, availability of equipment, and equipment that supports the implementation of high school chemistry lab work according to the Minister of National Education of the Republic of Indonesia Number 24 of 2007. Observation sheets are made in tabular form according to the observation aspect grid; b) Interviews, interviews were conducted with chemistry subject teachers, laboratory assistants, and several students representing each science class. Information that can be obtained through interviews is about the intensity/frequency of the Chemistry practicum, what practicum is being carried out, and how the practicum is carried out and the obstacles faced; c) Distribution of questionnaires, questionnaires are given to chemistry subject teachers and laboratory assistants. The questionnaire was used to find out about the types of practicum activities carried out, how the practicum was carried out, and to see other factors related to practicum activities such as laboratory conditions, time for practicum implementation, preparation and implementation of practicum, reports and practicum evaluations. Questionnaires are in the form of a number of questions to which the answers have been provided (structured questionnaire).

The data analysis in this study was guided by the data collected and the research objectives. The data were analyzed descriptively and used the percentage formula (%) [13]. The results of the calculation of the percentage of observation data were interpreted and compared with the laboratory readiness standards in accordance with the Minister of National Education of the Republic of Indonesia Number 24 of 2007.

III. RESULT AND DISCUSSION

A. Chemical Laboratory Readiness

The Minister of National Education of the Republic of Indonesia Number 24 of 2007 has established a minimum standard of infrastructure for a chemical laboratory in SMA/MA. One of them is the laboratory building area. The area of a good chemistry laboratory according to national education standards that mention in government regulation is 48 m²/20 students with a minimum width of 5 m. Based on the results of observations, it is known that the state of the chemical laboratory layout in the school that is the research sample has been in accordance with laboratory standards based on government regulations. One of the five laboratories observed is still a science laboratory. The laboratory is equipped with one storage room, has good ventilation, and the flow of electricity and water is smooth. The condition of the building and the area of the chemical laboratory building in the sample school can be seen in Table 1.

TABLE I. THE STATE OF THE CHEMICAL LABORATORY BUILDINGS IN THE SAMPLED SCHOOLS

No	Samples	Laboratory room area (m2)	Laboratory room width (m)	Storage area (m2)	Information*
1	School 1	126,99	5	41,5	Appropriate
2	School 2	94,4	8	18	Appropriate
3	School 3	49,8	6	4,41	Less Appropriate
4	School 4	120	8	24	Appropriate
5	School 5	89,68	7,6	22,8	Appropriate
		48/20 students	minimum 5	18	

* Appropriate to National Education Standards in Regulation of the Minister of National Education of the Republic of Indonesia Number 24 of 2007

Laboratory building arrangements should follow various rules developed by either international agencies or governments. The chemistry laboratory room functions as a place for practical chemistry learning activities that require special equipment. In addition, a good chemistry laboratory room can accommodate a minimum of one study group, has facilities that allow adequate lighting for reading books and observing experimental objects. To anticipate accidents, chemical laboratories have at least two doors, namely the entrance and the exit. Besides that, the location of the laboratory building must also be considered, the chemical laboratory is built in a place that is some distance away so as not to contaminate the environment.

The chemistry laboratory in the sample school has one laboratory principal who is also a teacher at the school. Not all chemical laboratories have laboratory assistants in managing laboratory infrastructure. However, every chemical laboratory tool and material has been inventoried by the head of the laboratory, although the inventory activity is limited to reporting the conditions of the facilities and infrastructure in the chemical laboratory. A good chemical laboratory room in accordance with government regulations is equipped with furniture, educational equipment, educational media, consumables, and other equipment. The readiness of laboratory facilities is viewed from three aspects, namely the type, ratio and description of the infrastructure. The type aspect shows the kinds of facilities a chemical laboratory must have. The aspect ratio shows the minimum number of each type of equipment a chemical laboratory must have. Meanwhile, the description shows the conditions and specifications of each type of facility that must be owned by a chemical laboratory.

Based on the results of observations, the type of facility not owned by all chemical laboratories in the sample schools was a fume hood. Fume hoods are indispensable in chemical laboratories, as an intermediary when transferring concentrated acid compounds during dilutions, as well as mixing chemical compounds that produce harmful vapors and fumes. A fume hood is one of the minimum facilities a chemical laboratory must have. In terms of the aspect ratio, the percentage of facility readiness in each sample school chemistry laboratory can be seen in Figure 1.

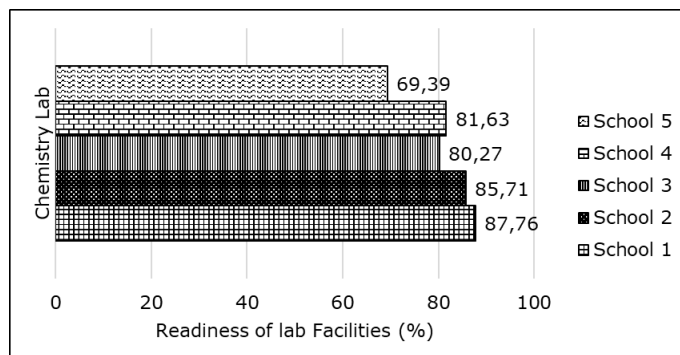


Fig. 1. Graph of laboratory facility readiness on aspect ratio.

The readiness of laboratory facilities in the aspect ratio shows the ratio of the number of facilities owned by the laboratory with the standard number stipulated in government regulations. The percentage of facility readiness in the lowest aspect ratio is at school 5. This occurs because there are 13 items of facilities that are not available in schools. The laboratories include: spray bottles, measuring flasks, dropper pipettes, fume hoods, funnels, barometers, distillation devices, stopwatches, test tubes, and first aid kits. These findings indicate that it is almost impossible for a chemistry lab to be carried out without these tools in a chemical laboratory. Furthermore, the percentage of facility readiness in the highest aspect ratio was at school 1, only two items of facilities were not available in the laboratory, namely, multimeter and fume hood. Other facilities, such as storage cabinets, demonstration desks, student desks, electricity sources, and student chairs, are all available in every chemical laboratory observed.

The results of the research by Rahman et al. show that one of the problems in implementing practicum activities in schools is the lack of facilities available in each laboratory, the lack of these facilities is due to the absence of special funds that can be disbursed annually for the provision of laboratory equipment and materials. as well as funds for equipment maintenance. Some schools took advantage of the school operational assistance funds to provide the tools and materials needed and urgent. Meanwhile, some other schools took the effort to submit proposals to related institutions for the provision of laboratory facilities, but the amount given was not sufficient to meet the needs within a certain period of time [14]. Wiratma and Subagia state that in science learning, chemistry is no exception, the laboratory is an inseparable part because the

laboratory is present as a vehicle for proving scientific concepts learned by students theoretically in class. In this case, the laboratory can be seen as a supporting facility for empirical learning to strengthen students' theoretical understanding that is learned through textbooks [15].

In addition to the ratio of the number of laboratory facilities, government regulations also regulate the description of the facilities that should be available in a chemical laboratory, such as size, condition, nature, and shape of the facility. Based on the results of observations, one of the schools sampled had facilities that did not match the description in government regulations. Among the facilities that did not match the description of government regulations were the condition of the sink, first aid kit, cleaning equipment, and chemicals. Apart from laboratory equipment, government regulations also regulate consumables that must be owned by a chemical laboratory. At least to use one to two times practicum. The types of practice include: a) Introduction to chemical reactions; b) separation and refining techniques; c) Acid-base titration; d) Electrochemistry; e) Energetics; f) Manufacture of applied chemical knowledge products.

All of the practicum activities mentioned above have been carried out in every sample school. However, in general, chemistry teachers prefer to use natural materials and those in the environment. In the interview, the teacher stated that the procurement of chemicals was not obtained every semester or every year. Some of the materials in the laboratory have expired, melted, and changed color, so they cannot be used anymore.

Some things that need to be considered in planning tools and chemicals for practicum are (1) the type of experiment to be carried out, (2) an understanding of the tools and materials to be purchased, (3) the available electrical power, (4) the specifications of the tools / types size of tools and materials to be purchased, (5) purchasing procedures, and (6) implementation of purchases [15]. In laboratory management after the process of procuring equipment and materials, an important thing to note is how to store chemical tools and materials in the laboratory. Tools and materials should be arranged properly so that they will be easier to use. Equipment and chemicals should be stored in a different cupboard and should not be mixed [6]. Addressing the problem of limited chemical laboratory equipment and materials, chemistry teachers can use the internet and books to find out the types of practicum that can be applied with simple tools and materials. Likewise, in terms of its implementation, in the interview, the chemistry subject teacher stated that he did more practicum with demonstration and assignment methods.

B. Implementation of Chemistry Practicum

The implementation of the chemistry practicum in the sample schools was known through the results of interviews and questionnaire answers by the chemistry field teacher. The frequency of the chemistry lab work is low. Based on the results of interviews with chemistry teachers, it is known that students carry out practicum one to two times each semester.

The low implementation of chemistry practicum based on the results of interviews is caused by several factors, namely: 1) There is no special time available for teachers, heads of labs, and laboratory assistants to prepare tools and materials and carry out practicum; 2) Lack of availability of chemicals in the laboratory; 3) Lack of knowledge of teachers and laboratory assistants in preparing practicum guides according to laboratory conditions; 4) Laboratory management and management that is far from evaluation and appreciation from schools and related agencies. Hamidu, et al. stated that practicum in the laboratory encourages the achievement of science education goals and increases students' understanding of science concepts, both in terms of application, practical skills and problem-solving abilities [16].

Heads of laboratories and laboratory assistants, assisted by teachers in the field of chemistry, try to plan, manage, carry out, and evaluate activities in the laboratory very well, even though they have never received special training and training in chemical laboratory management. Based on the results of the answers to the questionnaire by the teacher, it is known that the chemistry laboratory has been put to good use. Chemistry teachers carry out a chemistry lab in the chemistry laboratory room, practicum is held in 1-2 hours of lessons in 1 semester. Chemistry teachers also try to complete each practical activity according to the specified time.

In its implementation, the teacher in the field of chemistry studies the objectives of each chemistry practicum that will be carried out, gives a pretest, supervises and guides students, and asks students to clean the laboratory room after chemistry lab work is complete. As an evaluation material, the chemistry teacher asked students to make a report. Making reports and holding pretest aims to test the level of student understanding between the material and the results of the practicum carried out. Judging from the form of assessment, assessment in the affective and psychomotor domains has not been carried out optimally.

By implementing chemistry learning in the laboratory, it has an influence on the success of students in learning chemistry, students can study chemistry by directly observing chemical symptoms, can practice scientific thinking skills, can instill and develop scientific attitudes, be able to find and solve problems [17]. Thus Michael et al. stated that laboratory work is the core of any chemistry curriculum but the literature on laboratory skills assessment is still lacking. This also resulted in a lack of motivation in carrying out chemistry lab work [18].

Students will better understand the subject matter if they are actively involved in the learning process [19]. Based on the above opinion, it can be concluded that the implementation of chemistry practicum needs attention. With practicum activities, students can learn how to work with friends in a group so that students' social competences can be fulfilled. The implementation of chemistry practicum contributes to the learning process of chemistry, which makes it easier to study chemistry materials, and makes it easier to achieve knowledge competencies and shape student character.

IV. CONCLUSIONS

The readiness of the laboratory in the implementation of the chemistry lab work in the sample schools in terms of types, ratios, and descriptions of the facilities and infrastructure is generally in accordance with the Minister of National Education of the Republic of Indonesia Number 24 of 2007. The types of facilities that are not owned by all the schools sampled are fume hood. The frequency of practicum in the chemistry laboratory is classified as low because it is held only 2 times in 1 semester. This occurs due to other factors beyond the physical readiness of the chemical laboratory.

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