Assessment of Processes and Resources for Knowledge of Skills of a Chemistry Laboratory at the Senior High School of Ternate Island

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Abstract

This article discusses the influence of learning support processes and resources in the knowledge of Chemical Laboratory skills of high school students in Ternate Island. The learning process of chemistry in high school especially on laboratory, related to time/schedule allocation, practical purpose and achievement indicator in skill area become the focus of discussion on this aspect. While the supporting resources of learning, more emphasized on aspects of facilities and infrastructure such as the availability of educators, laboratory buildings, tools and chemicals that are based on the value of accreditation Senior High School in Ternate Island. in this study using 3 methods of collecting data such as survey techniques in schools, interview with teachers in schools and tests students' lab skills. The results showed that the knowledge of high school students' lab skills on Ternate Island is getting higher in schools with better accreditation. Skill Knowledge of High School Students in Ternate Island is still in the low category on the glass organizing aspect at the laboratory.

Keywords: laboratory skills, laboratory skills assessment, senior high school assessment

1. Introduction

1.1 Learning process of Chemistry Lab Skills in School

The assessment of chemistry learning at the primary and secondary level in Indonesia is still dominated by the evaluation of students' cognitive aspects. This is seen in the evaluation method used nationally using test techniques with the problem instrument on theoretical knowledge aspects. If that is the goal of education in schools is the improvement of students' knowledge, attitudes, and skills (Somez, 2017), how is the evaluation of attitude and skills aspects of schooling actually done?. This article tries to discuss students' abilities in chemistry learning in the laboratory on skill aspects based on measurements in schools.

The process of learning chemistry skills of students in the laboratory is manifested in practical activities. But not all high schools in Ternate have the same portion in organizing labs for students. The availability of existing facilities and resources is a separate consideration for teachers and schools to organize such activities. So that more chemistry learning activities conducted in the classroom. These constraints make the process and assessment of laboratory skills students do not have the same learning achievement at the high school level. The absence of an evaluation instrument on the knowledge of chemistry laboratory skills in high school students provides a broad space to develop learning achievement in the student skill domain at the school level.

1.2 Perspective to Build Knowledge from Experience of Chemistry in the Laboratory

Learning science in Indonesia has been introduced from an early age (3-5 years old) in non-formal schools. But more intensive new chemistry lessons are taught in high school. Along with the development of curriculum in high school, chemistry learning in high school initially focused on understanding the concept of chemistry on cognitive aspects, especially cognitive level 1 (remembrance) up to 4 (analysis) in Bloom's taxonomy. But now, with the enactment of KKNI-based curriculum, the achievement of high school students' learning is enhanced to think high level at level 5

(synthesis) and 6 (evaluation) on the cognitive domain (Bloom, 1956). While on skill aspect, high school student learning achievement is at 7 level, starting from perception level until creativity.

In the aspect of creativity in Bloom's taxonomy (Bloom, 1956), the learning achievement indicator is seen from the students' skills in designing, composing, creating, designing, combining, organizing, planning, and other equivalent activities. To be able to achieve this level, learning is required actively in order to be able to provide space and encourage the birth of student creativity. Active learning in chemistry can be carried out by using laboratory approach in practicum activity. Using this approach, students become object-based constructivist teaching that proves to improve student achievement and participation, as well as more focused attention on learning (Koseoglu & Tumay, 2010; Tatli & Ayas, 2013).

Chemical practice undertaken in schools aims to provide students with practical experience in enhancing their knowledge and scientific reasoning abilities, developing practical skills as well as to foster interest in science learning and teamwork. Work experience in the laboratory can also be useful to guide students to collect data from measurement results, and observations then build hypotheses and conclusions from the data set. In this process, there are several phases of student activities, firstly, how to choose and use the tools and chemicals correctly and safely. Observing, measuring and determining the result of lab work according to the purpose of the lab is the next phase. There is also an inventory of observed and measured data, organizing and analyzing the data so deserving to be described as a conclusion is the main phase of learning chemistry practicum in high school (Singer et al., 2006).

2. Method

Research data were taken using observation method, interview, and test. Observational methods were used to obtain school accreditation data, the distribution of students at the level of school accreditation, and supporting facilities in the chemistry learning process at school. Methods of interviewing teachers and students in schools to obtain information related to the implementation of chemistry labs in schools, while the test technique to students class XI of the senior high school was done to obtain knowledge data of students' chemistry skills in schools. Broadly speaking, the indicators of research instruments are presented in table 1.

Table 1. Observation, Interview, and Test Indicators

Observation	Interview	Test
High School Accreditation in Ternate	Teacher's teacher ratio	Ability to recognize safety and safety symbols in chemical laboratories
Distribution of students based on school accreditation	Number of chemical labs in school for a certain period	The ability to recognize chemistry
Availability of supporting resources	Objectives and outcome the implementation of lab work in school	Ability to identify the usefulness of chemical laboratory tools
		Ability to organize the use of chemical laboratory equipment

The test technique given to the students to know the size of the knowledge indicator of laboratory skill of class XI of the senior high school students is done with 51 items. There are 4 types of questions according to the validated table 1 indicator. The type of problem to know the students' ability in recognizing the security and safety symbol in chemical laboratory using validated matter, with the instruction to write down the meaning of 15 symbols within 10 minutes. Assessment of problem type 1, each correct answer is given score 2, being the wrong answer or no answer no assessment.

The second type of problem with the indicator to know the knowledge of the senior high school students in recognizing the chemistry tools in the laboratory, presented in 16 items with instructions about writing the name of the tool from the image in 10 minutes. In this type of assessment, the scoring system is still the same as the one type judgment; each correct answer will be given a score of 2, while the wrong answer and no answer get 0 or no score. While the type of problem 3 with the number of questions 6 grains with a working time of 6 minutes or the timing of each problem of 1 minute, students are asked to explain the usefulness of glassware in the laboratory in accordance

with the image that has been given. Assessment of problem type 3, each correct answer will be given a score of 3 on each answer question. While the wrong answer or no answer does not get the value.

The 4th measurement indicator is to know the ability to organize the use of chemical laboratory equipment, derived in type 4. In this type 4 problem, students are given instructions to describe the needs of some tools and the usefulness of each tool in a simple activity (eg weighing solids) in the laboratory. to complete 7 simple activities part of the lab chemistry laboratory, students are given a total time of 14 minutes with an average workmanship of each 2-minute problem. The assessment of type 4 tends to be more specific than the previous type of problem. In the case of type 4, students will be given a score of 1 is able to mention 1 needs of tools used in the simple activity. While the ability of students in describing the use of tools that have been mentioned previously will be given a score of 2 on each answer.

3. Results and Discussion

3.1 Senior High School Curriculum Perspective in Indonesia

The high school curriculum in Indonesia is very dynamic, it aims to improve the quality of education in Indonesia. Curriculum change in Indonesia was originally allegedly the impact of changes in the political system in government. But more than 1 decade, precisely starting in 2005, the government to formulate the curriculum in Indonesia leads to national standards based on qualification or better known as the Indonesian National Qualification Framework (KKNI). The secondary school curriculum in Indonesia is formulated by a high school curriculum drafting body under the directorate general of primary and secondary education which is followed and implemented in all secondary schools in Indonesia based on the decree of the minister of education and culture of the Indonesian republic. The implementation of the KKNI-based secondary school curriculum has been implemented in 2013 by way of conducting curriculum enforcement tests at several schools in Indonesia. The implementation of the KKNI 2013 curriculum based on KKNI in secondary schools emphasizes more on character education inherent in the assessment of 3 domains: knowledge, cognitive, affective and psychomotor aspects. In 2017 based on the decree of the head of primary and secondary education of North Maluku province, all schools in the province of North Maluku should have implemented the 2013 curriculum based on KKNI, including all secondary schools on the island of Ternate.

As a function of Indonesian government supervision on the implementation of national standards of education in secondary schools, accreditation is applied at every level and school to determine the feasibility of the program/school. The national accreditation board of madrasah schools (BAN-S / M) is a government-appointed body in implementing accreditation in secondary schools. The process of accreditation of secondary schools is conducted by using accreditation instruments compiled by the National Education Standards Agency (BSNP) which includes: (1) content standards, (2) process standards, (3) graduate competency standards, (4) educator standards and education personnel, (5) standard of facilities and infrastructure, (6) management standard, (7) financing standard and (8) educational assessment standard. Interest in the assessment process, especially on the knowledge and skills aspects of high school students in studying chemistry in Ternate Island, incorporates the criteria of secondary school accreditation as a reference of school resources in optimizing both aspects. Based on the observations of high school accreditation on Ternate island, there are 3 criteria of high school accreditation value as shown in table 2.

Table 2. Number and Criteria for Senior High School Accreditation on Ternate Island in 2016

Accreditation	Number of schools	Average value
A	10	92
B	7	82
C	2	63.5

Assessment of accreditation refers to the average total sum of the 8 assessed aspects of the school. To get an A grade, the school must reach an average of the minimum value of 86, for the accreditation range B is 71-85, while for the accreditation limit C is less than 71.

3.2 Human Resources in Senior High School Ternate Island

Aspects of human resources, especially the availability of teachers and laboratory in high school is also a concern, to determine the implementation of chemistry learning process in high school. Government regulation, in this case, is

related to teacher workload in school, based on the achievement of school teaching hours. For teachers who are certified as professional educators, they must have at least 24 hours of teaching time in a week. For chemistry learning in high school, the number of lessons varies weekly by class. The class X of the senior high school gets 2 hours of chemistry lesson per week. Class XI and XII science in the senior high school get hours of chemistry learning as much as 4 hours in one week. The one-hour duration of chemistry in high school is 50 minutes. Allocation of the number of hours is the amount of learning in which there is learning in the classroom or in the laboratory in the form of a chemical practicum. In the assumption of a simple count, a certified chemist/professional teacher in a week should teach a total of 6 classes to get the number of teaching hours as much as 24 hours. With the existing time allocation and considering the density of teaching a chemistry teacher in class, then this becomes a consideration of the effectiveness of chemistry learning process in the senior high school if it refers to the assessment of 3 aspects (cognitive, affective and psychomotor). The observation result, the average availability of teachers and high school chemistry laboratory in Ternate Island based on school accreditation has different in number. This is shown in table 3.

Table 3. Availability of High School Teachers and Chemical Laboratory at Ternate Island

School accreditation	The average chemistry teacher	Average chemical laboratory	Laboratory Availability
A	3	1	Chemistry laboratory
B	2	-	Science laboratory*
C	1	-	-

*) Integrated laboratory of biology, physics and chemistry

Besides the required supporting facilities in the laboratory in the form of tools and practicum materials, it is necessary also the arrangement and maintenance of facilities available. It is, therefore, necessary that management and personnel are able to manage the laboratory optimally (Rakhman, 2017). Human resources that are not less important than a teacher for learning chemistry, especially on aspects of knowledge and laboratory skills is a laboratory school. Laboratory assistant will help to inventory and prepare the needs of tools, and materials for practical work at school. The existence of laboratory in schools is also included in the element of school accreditation assessment. Minimum education level to be a laboratory assistance in the required senior high school laboratory is D1 (diploma 1) or equivalent with 1-year skill education after high school. It is expected that with the laboratory in the high school laboratory, will be able to build a chemical learning system especially knowledge and skills of the senior high school chemistry laboratory.

3.3 Learning Support Resources

Based on table 3, it can be further described the minimum standards/criteria availability of chemical learning support facilities at the high school in Ternate island. The availability of chemistry laboratory facilities varies according to the value of senior high school accreditation. One high school in Ternate Island with a value of 88, the second lowest grade of senior high school accredited A has facilities of chemical laboratory buildings, glassware practicum, basic instruments such as analytical balance and chemicals class A. Unlike one school with accreditation B with a total value of 80, has a scientific laboratory building (biology, physics, chemistry) in one building. Provide tools and chemicals for laboratory chemistry laboratory. While the senior high school with accreditation C with a value of 67, does not have a chemical laboratory building or science integrated. Chemical practice in this school is not implemented because of the lack of sufficient tools and materials. But the school provides the introduction of tools, materials and chemical experiments through demonstrations and video media.

Effective utilization of laboratories in schools is an important factor in practicum and chemistry learning. The availability of supporting facilities such as the performance or laboratory building, the tools, and precision materials can encourage active learning that leads to constructivist-based chemistry learning, which builds on a conceptual understanding of guided performance or guided observation (Samiasih, 2013). Another need that is still largely ignored in the laboratory in high school is the standard of safety and safety at the laboratory.

Since the Occupation Safety and Health Administration (OSHA) law was published in the United States, officially on laboratory standards entitled "Occupational exposure to hazardous chemicals in the laboratory", this rule has a dramatic impact on the safe operation of chemical laboratories. Some specific subjects produced or changed

dramatically as a result of laboratory standards include chemical hygiene plans, chemical hygiene workers, safety data sheets, safety and training information, standard operating procedures, student self-protective equipment and safety sources (Fivizzani, 2015).

3.4 Learning Laboratory Skills-Based

Standard learning processes that support the improvement of knowledge and skills of chemical laboratories are outlined in the high school accreditation instrument in general. In the standard of the content of the core competence of the knowledge of high school students especially the class of natural science is to understand, apply, analyze and evaluate factual, conceptual, procedural, and metacognitive knowledge at the technical level, specific, detail, and complex based on curiosity about science. Evaluating process of the implementation of subject learning in high school, each subject has a minimum completeness criterion (MCC), which is calculated by considering the complexity, carrying capacity, and intake of learners. MCC has different values between the senior high school with each other. By using the above 3 considerations in determining the value of MCC subjects, then the value of MCC senior high school with accreditation A is higher than the senior high school with accreditation B and C.

The MCC value of subjects in the senior high school is a representation of the overall learning of subjects, although there is a practicum in it. In learning chemistry in high school, MCC is a minimal criterion completing the study of chemistry both theory and practicum. Most high schools on the island of Ternate apply a scoring system based on student learning outcomes in the cognitive domain using test techniques. The percentage of chemistry practicum learning contributes no more than 10% of student learning outcomes. This results in an element of subjectivity in the evaluation of learning in high school, especially in chemistry subjects. Chemical learning in high school by applying the curriculum 2013, encourages learning activities oriented to the development of student character, where the cognitive, affective and psychomotor aspects of the aspect of evaluation that can not be separated. Unbalanced between the assessment between chemistry theory and the students' knowledge and skills in the laboratory, the lack of a high school chemistry learning evaluation system in Ternate. This is seen in the lack of chemistry practicum titles conducted in high school. 22 subjects in chemistry subjects, practicum can be implemented on 17 lab work titles spread in 3 science senior high school classes in 1 academic year.

The minimum portion of knowledge-based learning and chemistry laboratory skills in senior high school is due to the achievement of graduate learning at that level only on the understanding of theoretical concepts. So the senior high school with A accreditation should only provide a practical guide for at least 6 chemistry experiments in 1 academic year. High school with accreditation B provides a chemical practice guide of at most 6 experiments in 1 academic year. While high school with accreditation C does not provide guidance of chemistry guide because do not conduct chemistry lab in school. While the implementation of chemical labs in senior high school based on available infrastructure facilities has different frequencies. The frequency of high school chemistry practicum on Ternate island based on available facilities and infrastructure is shown in table 4.

Table 4. The Frequency of Senior High School Chemistry Experiment Based on School Accreditation

School accreditation	Frequency of Practicum	Percentage (%)
A	8	47.06
B	4	23.53
C	-	-

To improve students' competence in science subjects is not easy. The science of science requires more "active" components in its learning that can be seen from the work roles of students when inside and outside the laboratory (Hofstein, 2004). The most common inhibitors of laboratory factors are lack of time, and laboratory facilities at school (Darsana, 2014). In general, practicum activities in the School conducted at the chemistry lesson. If converted, one lesson in high school has 45 minutes duration. While learning chemistry in high school in one week can reach 6 hours of the lesson which is divided into 3 times face to face. So a one-time face-to-face learning chemistry has a time allocation of 2 hours of lessons or for 90 minutes. the allocation of practical learning time becomes a major obstacle in order to build a theoretical understanding of practicum activities in the School. Most students who do chemistry labs in groups in the laboratory tend not to be interested in the experiments performed because of the limited time practicum. This condition is very different from some countries such as UK, US, China, India, and Africa giving a 3-hour time allocation to students to complete the lab in school (Zakaria, 2011).

3.5 Chemical Laboratory Skill of Senior High School Students in Ternate City

Knowledge of chemical concepts based on theoretical understanding is very different from the knowledge of chemistry laboratory skills for students. Knowledge of high school students 'skills in chemistry laboratory is defined as the motor ability and students' understanding in taking, modeling and using glassware in Laboratory in accordance with the instructions given. The senior high school in Ternate Island does not describe the knowledge of chemistry laboratory skills separately with the knowledge of chemistry concepts taught in the classroom. In this article developed an instrument of measuring knowledge of different chemistry laboratory skills with test instruments used to derive student learning outcomes/achievements in chemistry subjects. The consideration of developing the knowledge instrument and skills of a chemistry laboratory is based on an understanding of the work within the chemistry laboratory. For knowledge instruments about chemical lab skills in the form of test questions, indicators and number of questions are shown in table 5.

Table 5. Indicators and Amount of Knowledge of Laboratory Chemistry Skills

Indicator	A acreditation	B acreditation	C acreditation
Ability to Know the Security Symbol and Work Safety at the Laboratory	67.03	61.07	22.50
The Ability to Know the Chemical Tool	66.97	62.38	7.81
Ability to Identify Use of Chemical Laboratory Equipment	15.89	6.00	1.39
Ability to Organize Use of Chemical Laboratory Equipment	3.30	0.77	0.54
Average	**38.30**	**32.55**	**8.06**

Based on table 5, shows knowledge of chemistry laboratory skills of high school students of class XI in Ternate are in the low category in accredited senior high school A and B, while students in accredited high school C have very low average value. More specific knowledge of students about chemistry laboratory skills can be differentiated based on several groups. Judging from the ability to recognize safety and work safety symbols in the laboratory, schools with A and B accreditation are in the high category, with an average student score of more than 61. While schools with accreditation C are in low categories with an average score of less than 40. The ability to recognize safety and work safety symbols in the laboratory was measured using an instrument of about 15 short essay items. In this instrument, the question of displaying images of material safety data sheet (MSDS) symbols of chemicals amounted to 10 items and safety symbol in the laboratory chemistry of 5 items about. Based on the indicators of students' knowledge in identifying the chemistry with the problem instrument amounted to 16 items, where students are asked to provide the name of the tool on the matter of the presented image. The result of the analysis shows that senior high school with accreditation A and B are in the high category, while senior high school with accreditation C is in a very low category with the average value less than 19. While on two indicators of student's knowledge in identifying usefulness and organizing the use of chemistry, the overall high school in Ternate is in a very low category with an average score of under 19 students.

Generally from the data of the result of the knowledge assessment of chemistry laboratory student skill in the senior high school Ternate Island is at the level of knowing laboratory practicum tool. This phenomenon can happen widely in Indonesia if you see the achievement of graduate learning on curriculum applied at high school level is the same. Although the chemistry laboratory in senior high school Kota Ternate with the same accreditation has varied frequencies between the senior high school with one another, the data shows the level of knowledge of students' chemical laboratory skills is in the same category. This is possible because the purpose of the chemistry practicum in the guidebook only refers to the students' cognitive understanding of particular learning materials. For example, in a reaction kinetics practice, the purpose of the practicum is to know the rate of reaction or to determine the reaction order of an experiment. Practicum activities using only cognitive objectives will be able to impact the less objective assessment in the evaluation of chemistry practicum learning. Potential students in conducting motor-related activities in the laboratory properly and safely need to be given their own appreciation and appraisal.

It is important to design a chemistry practice in the senior high school that leads to the assessment of students'

learning outcomes in the three domains, namely aspects of attitudes related to students' safety in laboratory work, cognitive aspects related to students' ability to draw conclusions in practical and psychomotor aspects that can encourage students in doing work in the laboratory accurately and precisely (Rakhman, 2017). This can be done by tiered steps each year of learning in school, by combining theoretical objectives with the student skills aspect. This means that the implementation of chemistry learning in high school needs to look at the whole, taking into account the three previously mentioned domains.

3.6 Knowledge of High-Level Chemistry Laboratory Skills of High School Students

The psychomotor ability or called skill is a student's physical activity in learning (Demiray, 2016). Learning outcomes in the psychomotor realm of learning have a role in helping students to become skilled and confident individuals (Tibrani, 2017). The psychomotor aspect is also useful in building students' theoretical understanding of the learning process (Prihatiningtyas, 2013). In addition, psychomotor abilities are able to motivate students to be more creative and innovative (Hamid, 2012).

The psychomotor ability of students can be influenced by various factors such as school facilities. School facilities that are less able to affect students' psychomotor abilities are evidenced by the research done by Haastrup Timilehin Ekundayo, on the impact of school facilities on high school student achievement in South-West Nigeria (Ekundayo, 2012). Psychomotor learning involves consistent and integrated operations with affective and cognitive aspects. In this learning, individuals learn the skills of how to use with the support of visual perception as well as exploring objects by touching them. (Hamid, 2012). Practical learning steps on skills aspect include; 1). Determining goals in the form of deeds. 2) Analyze the skills in detail and in sequence. 3) Demonstrate skill accompanied by a brief explanation by paying attention to key points including key competencies needed to complete work and difficult parts. 4). Provide an opportunity for learners to try to practice with supervision and guidance. 5). Provides an assessment of the learners' efforts (Direktorat Pembinaan SMA, 2010).

Skills learning strategies and methods for high school students that are effective in laboratories are laboratory demonstrations, this begins by demonstrating the main techniques or equipment operations, can also describe the location and handling of special materials. Instructional instruction in the laboratory by the teacher should be done actively, having a consistent interaction speed during the learning in the laboratory, so that students get practical learning (Hamidu, 2014). Practical learning in the laboratory can be done at the time of learning using chemicals and equipment in chemical laboratories (Tafa, 2012). The process of designing, working and organizing in a chemistry lab requires laboratory skills (Itzek-Greulich, 2015). Scientific skills in organizing tools and chemicals in the Laboratory are high-level skills. Therefore, chemistry learning through lab work in the laboratory needs to be done in stages, from familiar tools, using up to organize tools as high-level skills in high school students (Rakhman, 2017).

The context of high-level thinking skills that need to be discussed where the ability to think is more specific is targeted at questions, inquiries, and modeling. That is based on the principles of computerized laboratory-based learning units (CCL) and Computerized Molecular Modeling (CMM) developed within the framework of chemical syllabus reform in Israel (Kaberman & Dori, 2009). There are various ways of thinking, such as critical thinking, creative, problem solving, all of which are categorized as high-level thinking. This skill is widely used to solve or answer the level of analysis, synthesis, and evaluation of Bloom's taxonomy. This skill is thought to have not been widely owned by students, evident from the ability to answer questions or questions that are relatively complicated (Rakhman, 2017).

Training at the school laboratory first appeared in the nineteenth century. The purpose of training in the laboratory at the time was the motivation to improve the skills. Then the attention of learning in the Laboratory continues to grow to encourage social skills and cooperation (Tuula, 2003). Constraints that often faced by schools in conducting labs in the laboratory include lack of facilities, infrastructure, human resources to the limitations of teachers in managing to learn in the laboratory, due to practicum a lot of time and energy (Maknun, 2012). Some important and relevant reasons, how important laboratory learning is held in the senior high school among others; 1). School laboratory activities have special potential as a learning media that can promote the results of science learning for students. 2). Teachers need knowledge, skills, and resources sufficient for effective learning in a learning environment that enables students to interact intellectually and physically, involving investigations and direct thoughts. 3). Students' perceptions and behaviors in the science lab are strongly influenced by teacher-oriented expectations and practice-oriented practice guides, worksheets, and electronic media. 4). Teachers need a way to know what students think and learn in the laboratory and classroom (Itzek-Greulich, 2015).

4. Conclusion

In general knowledge of chemical laboratory skills of senior high school students in Ternate Island in the low and very low category. The availability of practicum support facilities in the senior high school has no significant effect on students' skill in identifying the utility and organizing tools in chemical laboratory. Several factors suspected to be the cause of the senior high school have not been able to develop knowledge of high-level laboratory skills, among others: not yet have the achievement indicator of chemistry laboratory skill learning, lack of supporting resources such as laboratory assistant, laboratory administration, labor safety standard in laboratory and lack of time allocation in high school.

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