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Analysis Basic Laboratory Skills of Preservice of Chemistry Teachers

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Abstract

This research aims to determine the basic laboratory skills of prospective chemistry teacher students and the number of chemistry practicums in higher education that support chemistry practicum in high school. This research is quantitative and descriptive. The subjects in this research were chemistry education students. The data collection techniques used were document studies, interviews, and questionnaires. The research instruments used were interview guidelines and questionnaire sheets. The research results show that the knowledge of basic laboratory technical skills of chemistry education students at UIN Sunan Kalijaga is still a good criterion. Skills that need improvement include calibrating digital and mechanical balances and making synthetic indicator solutions. As many as 33.3% of university practicum titles support school chemistry practicums. Therefore, follow-up action is needed to prepare chemistry teachers who master the concepts and skills of good basic laboratory techniques as provisions for guiding chemistry practicums in high school.

1. INTRODUCTION

Education has a vital role in the development and progress of a nation. Education can prepare the next generation, which has superior human resources, to face global competition (Minarti, Budi et al., 2022). The professionalism of teachers in carrying out their duties influences the quality of education. Teacher professionalism is the main factor in achieving academic goals. Professional teachers will create various innovations in the learning process to prepare students as the next generation with knowledge and character. Professional teachers must understand the learning material, methods, and student characteristics (Sukmawati, 2019). Therefore, the learning process requires skilled teachers.

A competent and professional teacher must have established competency standards and be able to demonstrate the qualities of a teacher in improving the learning process. The Minister of Education and Culture Regulation no. 16 of 2007 concerning academic qualification standards and teacher competency states that one of the competencies that chemistry teachers must have is the

ability to use measuring instruments, teaching aids, calculating equipment, and technology to improve the learning process in the classroom, laboratory, and field. Additionally, chemistry teachers must understand work management and safety principles and theories in school chemistry laboratories, design chemical experiments, and carry out chemical experiments correctly. This phenomenon shows that chemistry learning must equip students with experience of scientific process skills and scientific attitudes through practicum. However, many chemistry teachers need to gain adequate skills in managing laboratories, so implementing laboratory practicums is not optimal. Teachers also often ask students to do their practicums at home because the laboratory needs more equipment and materials in the laboratory (Burhanuddin et al., 2022).

Laboratories and practicums are essential and inseparable in chemistry learning (Reynders et al., 2019). The laboratory is the heart of chemistry learning because the laboratory can be a place to see, try, test, and assess scientific concepts learned in learning through practicums or experiments so that a better understanding is obtained (Khoiroh et al., 2021). Laboratories help make it easier for students to study and prove chemical theory to achieve knowledge competency and shape students' character and attitudes.

Practical activities are essential to support the quality of chemistry learning results and processes (Wahyuningtias et al., 2021). This practicum activity is more effective for improving students' expertise or skills and as a means of practicing using tools and materials in the laboratory (Eliyart & Rahayu, 2021). Through the practicum, students can observe, investigate phenomena, prove concepts they have learned, work in teams, and draw conclusions so that they can support their understanding of the material (Arini & Darmayanti, 2022). Practicum in the laboratory can also improve learning outcomes and student motivation (Husnaini & Chen, 2019).

Implementing practicums in school laboratories must be supported by the teacher's ability to manage practicum activities. A prospective chemistry teacher must master the concepts well and have strong laboratory practical skills. Preservice chemistry teachers must possess this knowledge and skills to have sufficient provisions. The knowledge that chemistry teachers have is not just knowledge of procedures, flow, or principles of experiments but must master basic laboratory techniques that are the basis for conducting chemistry practicums. However, based on facts in the field, most students still have low laboratory skills, and some have difficulty preparing practical chemistry materials (Zammi et al., 2018).

These basic laboratory technical skills are essential for prospective chemistry teacher students. Basic skills are crucial things that students must have so that practical work in the laboratory can take place correctly and run smoothly. Basic laboratory techniques include weighing skills, taking solutions using a pipette, preparing solutions, diluting solutions, measuring pH, filtering, and working safely in the laboratory. Mastery of basic laboratory technical skills is essential and is a necessary goal in the university chemistry education curriculum. Basic chemistry laboratory skills are skills related to a person's ability to manage tools and materials in a chemistry laboratory. Student's ability to use tools and chemicals, such as taking materials, making solutions, storing materials, observing, and working safely, shows basic skills in the laboratory (Eliyart & Rahayu, 2021). These laboratory skills cannot only be taught in one course but need to be trained and strengthened by increasing practicums so that the laboratory skills they have increase. Without a substantial provision of basic chemical laboratory technical skills, students will lack mastery and not pay attention to procedures for using the correct tools and materials in the chemistry laboratory, which will be dangerous (Ketut Sudiana et al., 2021). It is better to provide material on basic laboratory techniques to students from the beginning of the semester to support practicums and chemistry learning in class the following semester.

Knowledge about understanding chemical concepts, basic laboratory skills, and work safety in the laboratory dramatically influences the performance of practitioners. A lack of understanding of concepts and practical skills regarding basic laboratory techniques can cause performance errors in this laboratory. At the start of lectures, chemistry education students at UIN Sunan Kalijaga were not yet equipped with basic laboratory technical skills, so they were still awkward about using laboratory equipment during practicum.

Students lack good laboratory technical skills, so taking basic chemistry practicums is challenging. Most of the chemistry education students at UIN Sunan Kalijaga come from MAN graduates who had minimal practicums at school, so they had difficulty doing basic chemistry

practicums. Therefore, it is necessary to identify and describe the basic laboratory technical abilities of chemistry education students at UIN Sunan Kalijaga to prepare them for becoming preservice chemistry teachers. This activity was an initial step in improving the curriculum in courses that involve practicums to strengthen students' basic laboratory engineering skills at the start of their studies. This research aims to determine students' basic laboratory engineering skills as preservice chemistry teachers in the laboratory. This information is important in designing a program to prepare preservice chemistry teachers who are professionals in managing laboratories in schools.

2. METHOD

This type of research is quantitative descriptive research, which aims to determine the basic laboratory skills of chemistry education students at UIN Sunan Kalijaga Yogyakarta and the number of practicums that support chemistry practicum at school. The subjects in this research were lecturers who taught introductory chemistry practicum and chemistry education students at UIN Sunan Kalijaga semester 1, semester 3, semester 5, and semester 7 of the 2023/2024 academic year.

The data collection techniques used were document studies, interviews, and questionnaires. The research instrument consisted of an interview guide and questionnaire sheet regarding knowledge of basic laboratory skills. The questionnaire sheet consists of 4 aspects of basic laboratory technical skills: skills in weighing materials, skills in taking solutions, skills in making solutions, and skills in making synthetic indicator solutions with 20 statements. The indicators used can be seen in Table 1.

Table 1. The indicators

Aspect	Indicator
Weighing ingredients	Can weigh using analytical or digital scales correctly
	Can calibrate analytical balance before use
	Can weigh using mechanical scales or O haus correctly
	Can calibrate mechanical balance before use
Take the solution	Can take solution using a pipette
	Can take solutions using volume pipettes and suction bulbs
	Can take solution using measuring pipette and suction bulb
	Can take solution using a micropipette
Make a solution	Diluting a solution from a high concentration to a solution with a small concentration
	Diluting concentrated solutions such as concentrated sulfuric acid
	Making solutions with molarity units
	Making solutions with molality units
	Making solutions in parts per million units
Create synthetic indicators	Phenolphthalein indicator (pp)
	Biuret Indicator
	Fehling's indicator
	Benedict's indicator
	Starch Indicator
	Tollens Indicator
	Lugol's Indicator

Student questionnaires regarding basic laboratory technical skills were analyzed by converting qualitative data into quantitative data using the Guttman scale. Scoring rules using the Guttman scale can be seen in Table 2 below.

Table 2. Scoring rules using the Guttman scale

Description	Score
Yes	1
No	0

Next, calculate the percentage of students' basic laboratory skills using the formula:

$$\text{Percentage value} = \frac{\text{score obtained}}{\text{ideal maximum score}} \text{ x } 100\% \text{ .....(i)}$$

Change the percentage value obtained into a qualitative value according to the score interpretation criteria with the conditions in Table 3 (Arikunto, 2016).

Table 3. Score interpretation criteria

No	Score interval	Category
1	81%-100%	Very good
2	61%-80%	Good
3	41%-60%	Enough
4	21%-40%	Not enough
5	0%-20%	Very less

3. RESULTS AND DISCUSSION

This research aims to discover the essential technical skills of chemistry laboratories of chemistry education students at UIN Sunan Kalijaga Yogyakarta. The study was conducted using a questionnaire consisting of statements about basic chemical laboratory technical skills. The questionnaire consists of four aspects: skills in weighing materials, taking solutions, making solutions, and making synthetic indicator solutions. The results of the student basic laboratory engineering skills questionnaire in the odd semester of the 2023/2024 academic year can be seen in Table 4 below.

Table 4. Percentage value of basic laboratory technical skills

No	Basic laboratory techniques	Percentage Value (%) and Category				Total
		7th-semester student	5th-semester student	3rd-semester student	1st-semester student	
1	Weighing ingredients	62.5 Good	48 Enough	41.3 Enough	38.6 Not enough	47.6 Enough
2	Take the solution	100 Very good	100 Very good	100 Very good	75.8 Good	93.94 Very good
3	Make a solution	91.7 Very good	85.2 Very good	80.8 Good	53.1 Enough	77.7 Good
4	Create synthetic indicators	29.8 Not enough	24.3 Not enough	17.3 Very less	12.7 Very less	21 Not enough

Table 4 shows that the skill in weighing ingredients obtained a percentage value of 47.6% in the Sufficient category. Indicators used in this skill include weighing substances using an analytical balance correctly, calibrating an analytical balance, using an ohaus balance correctly, and calibrating an ohaus balance. An analytical balance is a tool for accurately weighing the mass of a chemical in the laboratory with a maximum load limit of 200 grams and an accuracy level of 0.1 mg. The working principle of this analytical balance is to weigh the mass of chemicals without the influence of free air with a high level of accuracy. The Ohaus balance is a tool for measuring mass quantities. This scale can weigh ingredients with an accuracy of up to 0.01 grams. Parts of an ohaus balance consist of a calibration button, weight holder, weights, balance arm, and balance line (Fidiantara et al., 2021).

The low value of students' skills in weighing materials is due to the lowest percentage value in analytical balance calibration and ohaus. Students do not master how to calibrate analytical balances and Ohaus balances. However, weighing skills using analytical and Ohaus balances are generally very good. The interview results also stated that most students could use analytical and Ohaus balances in practicum but did not understand how to calibrate them. Usually, the chemistry laboratory performs the calibration, and students use it only during practicum. This phenomenon causes students to lack the knowledge and soft skills to calibrate analytical balances and be thirsty.

Solution-taking skills obtained the highest percentage of 93.94% in the Very Good category. Indicators used include skills in taking solutions with dropper pipettes, volume pipettes, measuring

pipettes, and suction balls. Based on the interview results, it was stated that students had no difficulty in taking solutions during practical work in the laboratory. Therefore, the skill of bringing solutions can be mastered well.

The skill of diluting solutions obtained a percentage of 77.7% in the good category. Indicators of skills in diluting solutions include diluting solutions from large to small concentrations, making solutions from concentrated substances, and making solutions in units of molarity, molality, and ppm. Based on the interview results, most students could dilute the solution well.

The skill of making synthetic indicator solutions obtained a percentage of 21% in the sufficient category. Skills in making synthetic indicators include phenolphthalein (PP), biuret, Fehling, Benedict, Amilum, Tollens, and Lugol indicators. Most students do not have the knowledge and skills to make synthetic indicator solutions. Making this indicator solution is very important and needs to be owned by preservice chemistry teachers who manage chemistry laboratories in high schools. Based on the results of interviews, information was obtained that students from analytical chemistry vocational schools could mostly make synthetic indicator solutions.

The percentage value of basic laboratory technical skills is then grouped into each class. The total value of basic laboratory technical skills for each class can be seen in Table 5 below.

Table 5. Results of students' basic laboratory engineering skills

No	Research subject	Percentage (%)	Category
1	1st-semester student	45.05	Enough
2	3rd-semester student	60.0	Good
3	5th-semester student	64.3	Good
4	7th-semester student	70.8	Good
	Average	60.05	Good

Table 5 shows that students' average basic laboratory engineering skills are in a good category with a percentage of 60.05%. The percentage score of seventh-semester students is higher than that of lower-semester students. Seventh-semester students have better basic laboratory engineering skills than other semesters. The main factor that causes their skills to be high is that students have taken all the practicum courses and guided chemistry practicums at school during their teaching practice in high school. According to research by Saputri et al. (2018), the more experience students have doing practicums in the laboratory, the more students' knowledge will increase. First-semester students have the lowest percentage of scores because they have not done many chemistry practicums in college.

Document study is carried out by analyzing documents in the practicum module. This document analysis was carried out to find practicums in higher education whose titles directly support the material in high school. This analysis needs to be carried out so prospective teacher students are ready to conduct chemistry practicum in high school. Based on the results of the study, it was found that only around 33.3% of practicum titles in tertiary institutions supported practicums in high school.

Basic laboratory skills are fundamental during practicum in the chemistry laboratory. Based on the results of this research, it is necessary to improve basic laboratory technical skills to increase the professionalism of chemistry education students as prospective teachers. Many laboratories in Indonesia still need laboratory assistants to manage the laboratory, and teachers' skills in managing tools and materials have not been appropriately honed (Turrahmah et al., 2020). Therefore, chemistry teachers must be competent enough to prepare for practicums. The competencies needed are mainly basic laboratory technique skills. Thus, chemistry education study programs must design practicums to individually give students essential laboratory technique competencies. These skills will be crucial when there are no laboratory assistants in high school to help them prepare practicums.

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4. CONCLUSION

Based on the findings of the data analysis and discussion, it is possible to infer that the use of the discovery learning model in conjunction with the evolution video has a substantial impact on concept mastery and science literacy among XII-grade students at SMA Negeri 1 Ngaglik. The Mann-Whitney Test on pupils yielded a significance value of <0.001 for concept mastery and 0.032 for science literacy, indicating a value less than 0.05. As a result, the adoption of the discovery

learning model learning approach, aided by evolution videos, has been shown to improve concept understanding and science literacy in learning evolution, particularly among SMA Negeri 1 Ngaglik class XII students.

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