Jurnal Ilmu Sosial dan Pendidikan (JISIP)
Vol. 9 No. 3 Juli 2025
e-ISSN : 2656-6753, p-ISSN: 2598-9944
DOI: *10.36312/jisip.v9i3.8903*/*http://ejournal.mandalanursa.org/index.php/JISIP/index*

Effectiveness Implementation of The Practical Instrument to Assess The Ability of Affective and Psychomotor Aspects Pre-Service Chemistry Education Teacher Students in Laboratory Activities

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Article Info
Article history:
Received: 1 Juni 2025
Publish: 1 July 2025

Keywords:
Effectiveness;
Affective and Psychomotor Instruments;
Laboratory Activities.

Abstract
In *the practicum activities, there is still a lack of implementation time, due to ineffective instruments and work procedures. The purpose of this study was to determine the effectiveness of laboratory activity instruments on affective and psychomotor aspects. This study employs a quantitative descriptive approach in its survey design. The sample of the study consisted of students from the Chemistry Education Study Program, Faculty of Tabiyah and Teacher Training Ar-Raniry State Islamic University, Banda Aceh, in their third semester, who were taking practicum courses. There were 35 students, three lecturers teaching practicum courses, and two laboratory assistants. The data obtained were described quantitatively. The results showed that (a) the average student response to the use of the instrument was strongly agree 54.08%, agree 44.38%, and disagree 10.77%. In the affective aspect, the number of aspects that emerged ranged from 6 to 18 aspects within 100 minutes, while the number of aspects in psychomotor aspects ranged from 8 to 26 within the same 100-minute activity span. Based on these results, it was concluded that the practicum activity instrument was effective in assessing the affective and psychomotor aspects of students in practicum activities.*

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1. INTRODUCTION

Laboratory activities have long been recognized as an important component in chemistry learning, because they are able to bridge theory with proof of concepts learned. The laboratory plays an important role in improving conceptual understanding, problem-solving skills, and proofs, thus providing opportunities for students to explore chemical concepts directly and in depth. Laboratory activities are an integral part of chemistry learning that aims to help students connect theory with practice. Laboratory activities not only improve students' conceptual understanding (Hofstein and Lunetta, 2004), but also train critical thinking, problem-solving, and collaboration skills. In addition, practicums provide students with direct experience in understanding the scientific process, from experimental planning to data analysis. Millar (2010) emphasized the importance of designing effective laboratory activities in order to achieve learning objectives optimally.

Integration of competencies in practicum (Abrahams and Reiss (2023), such as basic knowledge with skills, significantly improves students' conceptual accuracy and understanding. In addition, activities in the chemistry laboratory encourage active involvement and the development of deeper scientific skills (Zhang et al., 2022). Practical assessment instruments as learning tools are a key element in ensuring the achievement of learning objectives in the laboratory. Valid and reliable instruments can help in evaluating students' practical skills objectively (Harlen, 2000), good assessments not only measure learning outcomes but also provide constructive feedback to improve the learning process itself.

The designed instrument focuses on measuring understanding and activity in the process of proving concepts in the laboratory. Well-designed practicums can improve students' ability to apply scientific concepts to real-world contexts (Millar, 2010). Abrahams and Reiss (2012) said that the effectiveness of laboratory activities is highly dependent on the instruments used to assess students' work skills and attitudes during practicum activities. Transparency and accountability in practicum assessment are essential to ensure fairness and consistency. Structured and evidence-based assessments can provide clear feedback to students (Sadler, 1989). Moskal and Leydens (2000) highlighted the importance of developing valid and reliable assessment rubrics to support a more objective evaluation process.

The aspect of effectiveness is one of the challenges in developing laboratory assessment instruments. Brown and Harris (2013) noted that instruments that are too complex can make implementation difficult, especially in laboratories with limited time and resources. McMillan (2014) also emphasized the need for a simple instrument design but still able to measure various dimensions of student skills effectively. The development of laboratory assessment instruments must be in line with the needs of the practicum competencies. Students not only need to master technical skills, but also critical thinking, collaboration, and communication skills. These skills can be obtained optimally if trained with effective instruments. The purpose of this paper is to; (a) determine the effectiveness of the implementation of the practicum instrument to assess the laboratory activities of chemistry education students in the affective and psychomotor aspects, (b) determine student responses after using the practicum assessment instrument to assess the laboratory activities of chemistry education students.

2. METHODS

This study is included in the type of survey using a descriptive quantitative approach to determine the effectiveness of the implementation of the practical assessment instrument in the laboratory activities of chemistry education students on the affective and psychomotor aspects. This approach was chosen because it can provide an objective picture of the effectiveness of student activity instruments in proving the concepts used during the practicum in the chemistry laboratory. This activity was carried out in the Chemistry Education study program at one of the universities in Indonesia. The subjects of the study were 32 third-semester students in the Chemistry Education Study Program, Faculty of Tarbiyah, UIN Ar-raniry Banda Aceh who were taking part in basic chemistry practicums. In addition, lecturers and laboratory assistants involved in the practicum activities also became respondents to provide information and input related to the use of assessment instruments.

The research instruments include: activity observation sheets using student response questionnaire sheets, and interview guidelines. Data collection was carried out as follows: (a) Observation: Carried out during the chemistry practicum activities in the laboratory with the aim of directly observing the implementation of the assessment instrument in depth by lecturers and laboratory assistants related to the affective and psychomotor aspects. (b) Spontaneous questionnaire: Given to students and lecturers to find out their perceptions about the effectiveness of the instruments used. (c) Interviews: Conducted to students, lecturers, and laboratory assistants in depth to obtain qualitative data related to obstacles in the implementation of the practical activity assessment instrument. Before being described, the data obtained was analyzed descriptively using the P=F/N formula, the reason being to measure the level of success of the instrument used to determine the effectiveness of the affective and psychomotor aspects. So that it is able to describe student competence in both aspects when carrying out practical activities in the laboratory.

3. RESULT AND DISCUSSION

This section will describe the results of validation, effectiveness, and student responses to the designed practical activity implementation instrument. The validation was conducted in a blended manner involving four universities, namely Syiah Kuala University, UIN Sunan Kaijaga Yogyakarta, UIN Sultan Syarif Kasim Riau, and UIN Ar-raniry Banda Aceh. The revised instrument was tested in the Chemistry Education laboratory of FTK UIN Ar-Raniry Banda Aceh.

The instrument was designed to contain three aspects, namely (a) Cognitive Aspect, (b) Affective Aspect, and (c) Psychomotor Aspect. The implementation of practical activities using the developed instrument was controlled using an observation sheet (attachment 3), implementation control was emphasized on two aspects, namely the Affective Aspect and Psychomotor Aspect for the reason of the concept proof activity. Cognitive assessment focuses on measuring theoretical understanding and application of concepts that have been learned (Harlen, 2000), while affective and psychomotor assessments play an important role in assessing students' attitudes, practical skills, and experimental processes (Hofstein & Lunetta, 2004). The affective aspect measures students' attitudes toward experiments, accuracy, and cooperation. The psychomotor aspect relates to technical skills in carrying out laboratory procedures correctly.

a. Result Research

The results of the implementation of practical activities using instruments to see the effectiveness

The data of the results of the implementation of the practicum using an instrument designed through observation activities, namely by observing 15 items of affective aspects. The activity was carried out in three practicum courses, namely basic chemistry practicum, solution chemistry, and biochemistry. The average observation results obtained in the skills and affective aspects are presented briefly in Figures 1 and 2 below.

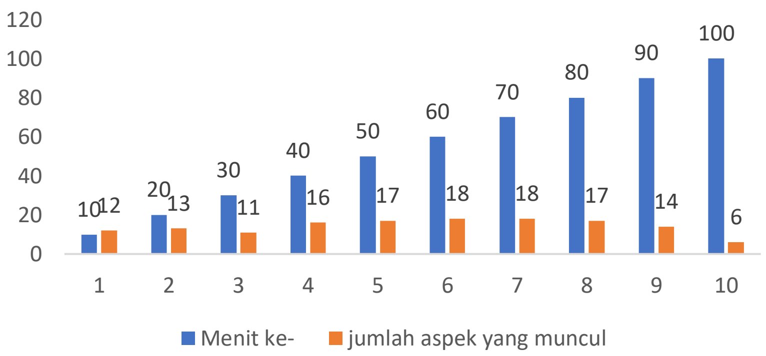

Figure 1. Graph of instrument implementation on the affective aspect

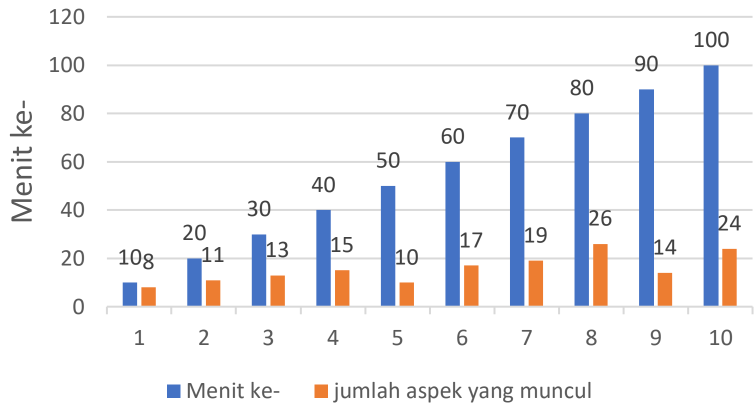

Figure 2. Graph of instrument implementation on psychomotor aspects

Student Response Results

To obtain student responses to the use of the developed instrument, researchers collected information using a questionnaire instrument with 18 items. The sample used as respondents was 32 students. The results of student responses after using the developed instrument can be explained in the following table.

Table 1. Student responses to the implementation of the developed practicum instrument

No	Respons Aspects	Result Respons (%)			
		Strongly agree	agree	Less Agree	Strongly agree
A.	**Pre-Practicum**				
1	Participating in practicum response activities				
2	Making flowcharts in work procedures	61,3	38,7		
3	Preparing practicum needs (assembling, arranging tools and materials, etc.)	29	48,4	22,6	
4	Checking the completeness of practicum tools and materials	61,3	38,7		
B.	**Implementation of Practical Activities**				
1	Conduct experiments according to the work procedures contained in the practicum module	74,2	25,8		
2	Ask questions about experiments that are not understood	61,3	38,7		
3	Create a theoretical basis in the form of a journal that is appropriate for the practicum being carried out	45,2	48,4	6,4	
4	Dress according to laboratory regulations equipped with protective equipment	71	29		
5	Attach MSDS (Material Safety Data Sheet) for tools and materials	41,9	54,8	3,3	
6	Observe practicum data carefully and thoroughly	71	29		

No	Respons Aspects	Result Respons (%)			
		Strongly agree	**agree**	**Less Agree**	**Strongly agree**
7	Take practicum materials neatly and without scattering and according to needs.	58,1	41,9		
8	se tools with the correct technique	64,5	35,5		
9	Write, record, record document observation data according to the specified time duration.	58,1	41,9		
10	Present observation data systematically and communicatively.	45,2	54,8		
11	Discuss the results of observation data analysis	45,2	54,8		
12	Ask questions about the results of data analysis that are not understood	58,1	41,9		
13	Describe the results of data analysis for discussion in reporting	41,9	58,1		
14	Conclude the results of the practicum properly and correctly	48,4	51,6		
15	Clean and tidy up tools after use	58,1	41,9		
16	Clean and tidy up the practicum table from trash and materials that have been used.	64,5	35,5		
17	Return tools to their original place in a dry condition	48,4	51,6		
C. Pasca Practical					
1	Systematic truth of the report	51,6	48,4		
	Average	**54,08%**	**44,38%**	**10,77%**	

4. DISCUSSION

Based on the data obtained, the distribution of responses to the assessment instrument showed quite positive results, with 54.08% of respondents stating that they strongly agreed, 44.38% agreed, and 10.77% disagreed. These results illustrate that the instrument developed can be said to be effective in assessing the implementation of practical activities. An effective instrument must cover various aspects of assessment, including cognitive, affective, and psychomotor (Harlen, 2000), all of which contribute to a more comprehensive understanding of student abilities in the context of laboratory activities. However, there were three items that received negative responses (disagree), which were related to (1) preparing practical needs (assembling, arranging tools and materials, etc.), (2) creating a theoretical basis in the form of a journal that is appropriate for the practical work being carried out, and (3) attaching the MSDS (Material Safety Data Sheet) of tools and materials. This negative response indicates a mismatch between the expectations of the instrument and the practices in the field. Effective lab assessments not only cover technical skills (Abrahams and Reiss, 2012), but also assess the extent to which students are able to connect theory with practice and ensure safety in every experiment conducted. This is important considering that lab assessments not only measure the success of experiments, but also how students plan and carry out lab activities safely and efficiently.

The three items that were not agreed upon, namely laboratory preparation, journal writing, and safety supervision, reflect common challenges in teaching laboratory activities in chemistry education. A good laboratory should integrate conceptual understanding with practical skills, which are not only limited to conducting experiments but also to careful planning and safety considerations (Kernis & Becker, 2022; Lee et al., 2021). In this case, the lack of adequate preparation, such as assembling equipment and materials or writing appropriate journals, may indicate that students have not fully developed the planning skills needed for a successful laboratory (Zhou et al., 2023). In addition, the absence of supervision related to MSDS may indicate deficiencies in the implementation of safety aspects, which are also very important in chemistry laboratory activities.

It is important to note that the assessment instrument must cover all aspects of skills required in laboratory activities, including planning, conducting experiments, and safety aspects, to ensure that students obtain a comprehensive learning experience (Liu, Wang, & Jin, 2023). As a solution, the instrument can be improved by including more in-depth evaluation elements regarding laboratory readiness and safety management (Martinez et al., 2022), which can support the achievement of optimal laboratory learning objectives (Ledya, Situmorang, & Silaban, 2024). This information is supported by the results of in-depth interviews with students, laboratory assistants, and lecturers in charge of practical courses, that during practical activities with instruments, there is a hierarchy of activity flows that are easy to follow, easy to use, and time-saving. These results prove that the instruments used are effective for chemical practical activities in the laboratory.

The findings obtained in the study were (a) able to develop skills, careful and careful attitudes in carrying out student practical activities in the laboratory. (b) Students can integrate knowledge, competencies and proof of concepts in learning practical courses. (c) Students are more effective in terms of time.

5. CONCLUSION

Based on the discussion above, the use of practical activity instruments in the laboratory is easy to follow the procedure, easy to use, and effective in terms of time. The results are shown in; first, the student's response after carrying out practical activities consisting of pre-activities, during implementation, and post-practical activities in the laboratory using the instrument. Second, the results of observations of the implementation of practical activities, both in terms of effectiveness and psychomotor aspects. Third, the results of interviews with students, laboratory assistants, and lecturers in charge of practical courses as presented in Figures 1 and 2, and the student response table.

6. ACKNOWLEDGEMENT

Thanks to the research institute of Ar-Raniry State Islamic University Banda Aceh, Litabdimas Ministry of Religion of the Republic of Indonesia who have funded this research, the research team, the head of the chemistry education study program who has given the opportunity to the researcher to collect data on the study program. Thanks also to the head of the chemistry education laboratory who has helped in the data collection process. Thanks to all parties who cannot be mentioned one by one in making the research a success.

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