

Development of Guided Inquiry Green Chemistry Practicum Guides

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Abstract— This study aims to determine the feasibility of guided inquiry green chemistry practicum developed based on the results of standardization and the opinion of expert validators. This research used the Development Research method with the development of the ADDIE model (Analysis, Design, Development, Implementation and Evaluations). The sample in this study were 3 chemical practicum guides of class XI that have been circulating. The validator in this study were 6 chemistry teachers, and 2 chemistry lecturers at Medan State University using developed BSNP-based validation questionnaire. From the results of the teacher and lecturer validation of the chemistry practicum guide developed showed that the guided inquiry green chemistry practicum guide is very feasible to use as a practicum guidebook, which the result of the analysis to four practical guiding components is in average value of 4.78

Keywords: *Chemistry practicum guide, green chemistry, guided inquiry, Feasibility Test, BSNP.*

I. INTRODUCTION

Education is a major component in improving the quality of a nation [1]. Chemistry is a part of science that deals with natural phenomena systematically, not only a collection of knowledge in the form of facts, concepts or principles, but also a process of discovery [2]. Therefore, chemistry study does not only focus on delivering material but also involves practical activities. In chemistry learning, it requires supporting activities such as practicum [3].

With practicum activities, abstract and micro chemical concepts will appear more concrete and easier for students to understand [4]. In addition, other studies also reveal that practical experience in the laboratory is recognized as a way

of achieving learning goals that can improve student's understanding of concepts in the science and application of scientific skills, problem solving skills and scientific thinking habits [5].

Feyzioglu examined the relationship of practical activities in science process with student learning outcomes in chemistry learning. It showed positive and significant relations with significant coefficient values $r = 0,653$ and $p = 0,000$ [6]. Practicum activities can also give opportunities for children to practice their reasoning skills, rational thinking skills and also applying scientific attitudes and methods in finding the truth of what they learn [7]. Hofstein stated that appropriate practicum activities will play an effective role in honing cognitive, metacognitive, ability to do practicum and student's interest in chemistry learning [8].

The most common constraints encountered in the implementation of chemical labs are the security problems in practicum, long time consume and expensive chemical material. However, these obstacles can be overcome by the application of green practicum methods [9]. This method has several advantages that can overcome the problems above, it is safe to do by the practitioner because the material used is natural, can be done anywhere and anytime, and the material used in this practicum method has an affordable price [10].

For many students, laboratory work means manipulating equipment but not manipulating ideas [11]. Therefore, many science educators have advocated the use of guided inquiry-based practicum guides [12]

Inquiry learning model is a series of learning activities that emphasize the process of thinking critically and analytically to seek and find out the answer of problem questioned [13,14,15]. Practicum activities using guided inquiry models

will encourage students to be actively involved in discovering their own concepts, knowledge through practicum using scientific methods that are assisted by practicum guides.

II. METHOD

This study starts from August 2018 - May 2019. The population in this study were the circulated chemistry practicum guides class XI. The sample of this study were taken by purposive sampling. Purposive sampling is non-probability sample that is selected based on characteristics of a population and the objective of the study. The sample in this study were 3 circulated chemistry practicum guides class XI published by Bumi Aksara, Pustaka Widyatama, and Katalis Datesa Prima. The validator in this study were 6 chemistry teachers with minimum qualification of bachelor (S1) that know and understand about chemistry practicum guides, 2 chemistry lecturers at Medan State University with postgraduate degrees and actively teaching.

The research instrument sheet to asses circulated and developed practicum guides refers to the feasibility questionnaire of the National Education Standards Agency (BSNP) book and has been modified in accordance to the practicum guides. The questionnaire used Likert scale guidelines in measuring the scale. The scale of questionnaires is ranged 1 to 5, meaning 1 as the lowest score and 5 as the highest score. The determination of the range can be known through the highest score range minus the lowest score range divided by the highest score with the criteria that can be seen in table I.

TABLE I. PRACTICUM GUIDES VALIDATION CRITERIA

No	Average	Variable Criteria
1	4,21-5,00	Very valid and no revision
2	3,41-4,20	Valid and no revision
3	2,61-3,40	Moderately valid and no revision
4	1,81-2,60	Slightly valid, half revision
5	1,00-1,80	Not valid dan full revision

This type of research includes research on R&D development by using the ADDIE model (*Analysis, Design, Development, Implementation, and Evaluation*). Development research was a research method used to produce certain products and test the effectiveness of these products [16].

III. RESULT AND DISCUSSION

The initial stage of this research began by distributing questionnaires related to the laboratory facilities, equipments, and supplies in public or private high schools. The distribution of this questionnaires aimed to determine the facilities of the laboratory, hence it can predict which chemistry practicum guides that can be developed based on their facilities, equipment, and supplies mentioned on the questionnaires. Overall, the results of the lab availability number, laboratory facilities, feasibility of equipment, supplies and safety work equipment of high school laboratory can be seen in the bar chart of Figure 1,2,3 and 4.

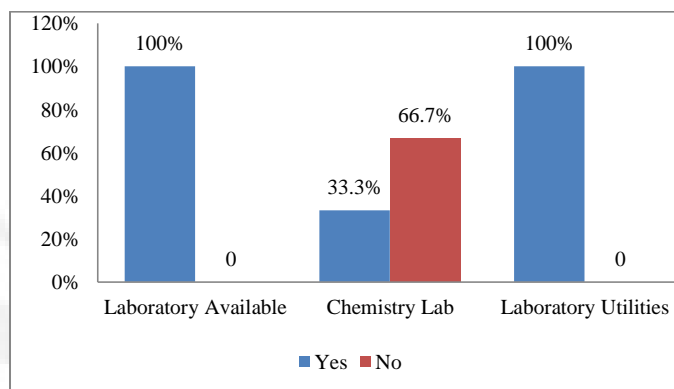


Fig 1. The Availability of Chemistry Lab

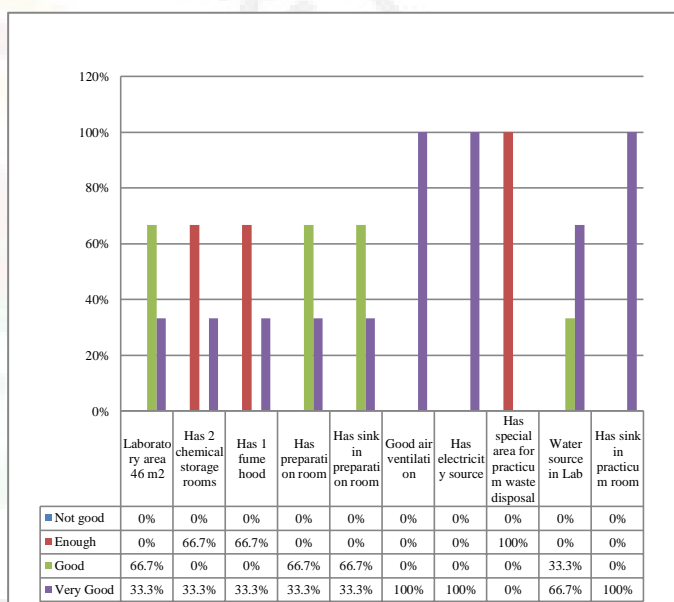


Fig 2. The Feasibility of Chemistry Lab (Physic)

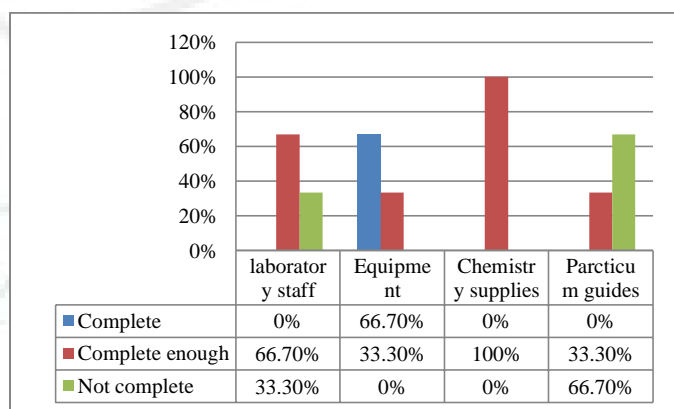


Fig 3. The Feasibility of Lab Equipment, Supplies, and Facilities

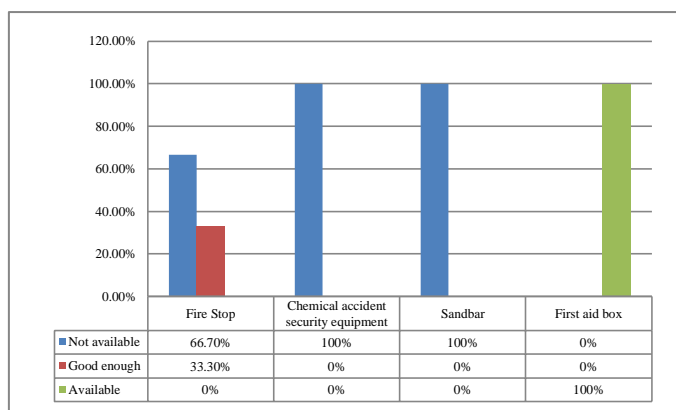


Fig 4. Work Safety Equipment in Lab

Based on results above, green chemistry practicum guides can be best solution as current labs are lack of equipment and supplies to support practicum activities.

Next stage is analyzing circulated practicum guides. 3 analyzed practicum guides have been standard by National Education Standards Agency. Overall, the average assessment value of 4 aspects analyzed in the first semester chemistry lab guide A, B, and C can be seen from the bar chart in Figure V. below :

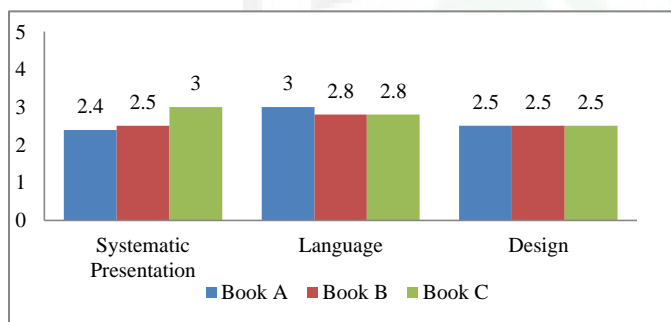


Fig 5 Feasibility of Book in Systematic Presentation, Language and Design Aspects

Average value of systematic presentation 2.6, average value of language 2.9 and average value of design 2.5 good enough and need revision. Analysis results of the circulated chemistry guide and things that need to be revise can be seen in Table II.

TABLE II. ANALYSIS OF CHEMISTRY PRACTICUM GUIDE COMPONENT THAT MUST BE REVISED AND DEVELOPED

No	Analyzed component	Existing practicum guides	Practicum guides that will be developed
Practicum areas:			
1	Suitability of practicum with basic competencies and core competencies	Haven't include basic competencies and core competencies	Including basic competencies and core competencies
2	Suitability of practicum objectives with learning indicators	There are no learning indicators.	Learning indicators and objectives written
3	Work rules in the laboratory	There are no work rules	Work rules included in practicum guides

4	Introduction of equipment, the use, maintenance and equipment Figure	Not every guide has introduction of equipment, the use, maintenance and equipment Figure is black and white	Introducing the equipment, the use, maintenance and equipment Figure has to be colored
5	Safety work guide instructions	There are no safety work guide instructions	Including safety work guide instructions
6	Suitability of practicum contents / stages with inquiry learning model	Practicum contents / stages haven't suitable for inquiry learning model	Practicum contents / stages are suitable for inquiry learning model
7	Assessment of report making and practicum activities	Not every book has assessment of report making and practicum activities	Including assessment of report making and practicum activities
8	Suitability of practicum contents with green chemistry principles	Contents of practicum guides not suitable for green chemistry principles	Contents of practicum guides must be suitable for green chemistry principles
9	Akura facts; all equipment and supplies for chemistry experiments.	Have not given challenge for nature supplies appliance	Using nature equipment and supplies in chemistry experiments
10	Including productivity knowledge	Have not fostered the spirit of innovation and creativity	Fostering the spirit of innovation and creativity using nature supplies and equipment.
11	Stimulate curiosity	Have not stimulated curiosity and challenges, as it use complete supplies	Stimulate curiosity, as it use easy obtain supplies
12	Developing life skill	Have not grown green care and handling waste from lab work	Growing sense of green care and handling waste from lab work
13	Developing Indonesia environment	Have not used environment potential in practicum	Using environment potential in practicum
14	Systematic Presentation	Practical presentation has not been integrated with the learning model	Practical presentation is integrated with the guided inquiry learning model

From the data analysis of the availability of chemistry lab and analysis of circulated practicum guides, next step to be done is plan and design the practicum guides needed.

Therefore, we revised the development product and requested feedbacks, insights, and comments from 6 chemistry teachers and 2 UNIMED chemistry lecturers. After practicum guides have been revised, then we tested the feasibility standard from aspects of content, presentation, language and design, by giving standard validation questionnaire to the chemistry teacher and validator lecturer. Questionnaires arranged are scored with range of values 1-4 for each aspect. The score obtained is summed and averaged to obtain data to determine the feasibility standard of each aspect of the chemical practicum guide.

Based on the results of the assessment by respondents totaling 6 teachers and 2 lecturers, the practicum guide developed was very suitable to be used for learning. All aspects of the assessment of the average practical guide can be seen in Figure VI

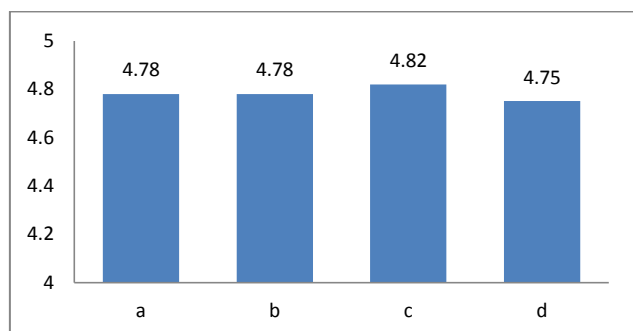


Fig 6. Result of Four Components of Developed Practicum Guides

Description:

- A. Content feasibility
- B. Language
- C. Systematic presentation
- D. Design

All aspects assessed based on validation data from 6 chemistry teachers and 2 UNIMED lecturers can be averaged 4.78 with very feasible criteria

IV. CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that: The level of feasibility of the chemistry practicum guide for High School/Islamic High School class XI in semester 1 issued by several publishers has a fairly decent category, but there are several components of guidance that need to be developed. And the results of the validation of teachers and lecturers on four components of developed green chemistry practicum guides based on guided inquiry in High School / Islamic class XI semester1 has an average value of 4.78, means very feasible, thus it is suitable for chemistry learning.

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