

Development of Green Chemistry-Based Practical Guide Book in Science High School Students Class X Even Semester

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Abstract - Practicum activities in the laboratory are important things to do in learning chemistry. However, in the fact, practicum activities in various schools still have many obstacles such as lack of time, tools and materials that are not yet available according to the needs and implementation of practicums that are not yet environmentally friendly and endanger students so that practicum activities are rarely performed. Therefore, in this study the chemical laboratory handbook was developed using a chemical that is safe, environmentally friendly and based on green chemistry. In addition, this guide also contains how to use tools and materials, laboratory techniques, making of the solutions, and work scheme in the form of drawings that aim to conduct practicums safely and smoothly. This study uses a 4D development model. The targets in this study are the validity, practicality and effectiveness of guidelines for student learning outcomes. Based on the results of data analysis, it appears that the practicum guides developed are very feasible and practical to be applied in chemistry and practicum learning because they get "Very Good" scores. The effectiveness of the guide seen from student learning outcomes. The Gain N Score obtained in this study was 0.61, from this result it can be concluded that the use of the "Quite Effective" guide on improving student learning outcomes.

Keywords - Guide, Practicum, Green Chemistry.

I. INTRODUCTION

The aim of learning chemistry as part of the curriculum is the development of chemical literacy, introducing chemistry to high school students so that they have an adequate foundation and are interested in studying chemistry, developing scientific thinking skills and growing awareness of moral responsibility regarding the use of chemical processes and products (Noh, 1997; Ling, 1997; Tongwen, 1997). This goal can be achieved by focusing on the Characteristics and achievement of science. (Mulyasa, 2006: 132–133). The one of way to achieve the goals of chemical education is to carry out practicum activities. Practical activities in science learning aim at teaching laboratory skills; helping to acquire and develop concepts, and develop social skills (Hodson in Pullaila, 2007).

The benefits of practicum for students can be summarized into three domains, namely to develop cognitive domains,

affective domains, and psychomotor domains, for example is science process skills. (Willington, in Ketpichainarong, et al., 2010). This is in line with the purpose of learning chemistry in high school. However, the implementation of chemistry practicum as one of the teaching and learning activities at the high school level has several challenges, such as the availability of facilities and infrastructure to support practicum activities, the availability of adequate budget especially for the purchase of chemicals and other consumables, the availability of sufficient time to carry out practicum, risk level or work safety in practicum implementation and waste management resulting from chemical practicum activities (Coppola, 2008; Hadisaputra, 2017).

Because of the importance of practicum implementation in learning chemistry and with the

problems that result in chemistry practicum activities at the high school level is rarely or not implemented, it is necessary to make efforts to optimize the implementation of practicum activities by selecting experiments that do not require a long time, low danger level, using safe and environmentally friendly materials, using chemicals with low concentrations and quantities, using materials that are easily found in everyday life and inexpensive, using tools that are easily found in the surrounding environment, using work schemes in the form of images, making, not choosing experiments with topics that are close and familiar with student life. Experiments with these characteristics are in accordance with the concepts and principles of green chemistry.

II. LITERATURE

Practicum is part of teaching that aims to give students the opportunity to test and implement in real situations what students have obtained in theory. Practicum aims to help students build knowledge structures and ways that can be done to gain knowledge. In carrying out the practicum, a guidebook is needed. Practicum Guide or Guidelines are guidelines for practicum implementation which contain procedures for preparation, implementation, data analysis and reporting. The guideline was compiled and written by the teaching staff who handled the practicum and followed scientific writing (Ministry of National Education, 2001: 230). The preparation of the practicum guides has the aim to activate students and assist students in developing process skills.

Students who get practicum guides are expected to be more active in practicum activities. Students not only receive the knowledge and skills provided by the teacher, but also can find or acquire it themselves without the help of the teacher (Meyhandoko, 2013: 12). A good guide for practicum, besides having these components, should also have aspects of work safety in carrying out the practicum. The safety aspect in practicum guides can be written warnings. In addition, the safety aspect can also be in the form of illustrated symbols. According to Rustaman, the benefits of practicum guides include; (1) can achieve mastery learning, (2) foster scientific work habits, (3) to provide feedback to teachers in developing more varied and meaningful learning designs (Meyhandoko, 2013: 11)

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III. METHODOLOGY

The type of research used is educational development research or Research and Development (R&D). The development model used in this study is the 4-D model. The Thiagarajan model development procedure consists of four stages, namely the define phase, the design phase, the develop phase, and the disseminate stage.

The subject of this research is a guideline based on green chemistry. Assessment of the validity of the guide is carried out by a chemistry lecturer at UNP, the practicality of the guide is carried out by distributing questionnaires to Chemistry teachers and high school students.

Table 1. Validity and Practical categories based on kappa moments

Interval	Category
0,81– 1,00	Very high
0,61– 0,80	High
0,41– 0,60	Moderate
0,21– 0,40	Low
0,01– 0,20	Very low
≤ 0,00	Invalid

The effectiveness of the guide is seen from the increase in student learning outcomes before and after the use of the practical guide. N Gain% is used to see the effectiveness of the use of the guide with the results of pre-test and post-test with the same problem. The N-Gain score is obtained by the formula:

$$N\text{ Gain} = \frac{\text{Skor posttest} - \text{Skor pretest}}{\text{skor ideal} - \text{skor pretest}}$$

Table 2. Category interpretation Effectiveness N-Gain

N-Gain	Category
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Moderate
$g < 0,3$	Low

IV. RESULTS AND DISCUSSION

A. Define

At this stage interviews were conducted with teachers, students, study literature and KI and KD analysis of even semester X grade chemistry lessons. The results of the teacher and student interviews found that practicum activities in schools were rarely carried out, this was due to a number of constraints such as insufficient time, unavailability of chemicals needed, students were afraid of using chemicals and practicum which was not safe and environmentally friendly.

Therefore we need a chemistry practicum guide that includes several experiments on even class X grade chemicals using safe chemicals and tools. By using this guide, students can safely carry out chemical practicum activities because the tools and materials used are not dangerous and are often found and used in daily life, in addition to the guide, work schemes are also presented in the form of drawings so as to facilitate students in their implementation trials and can minimize workplace accidents, the resulting waste does not damage the environment. This chemistry practicum guide also contains information about the use of laboratory tools and techniques as well as the preparation of solutions to help teachers in practicing the practicum.

B. Design

Green chemistry-based chemistry lab guides are designed to provide solutions to practical implementation constraints. For constraints of inadequate implementation time, this guide presents a work scheme in the form of drawings so that students can more quickly and easily carry out experiments.

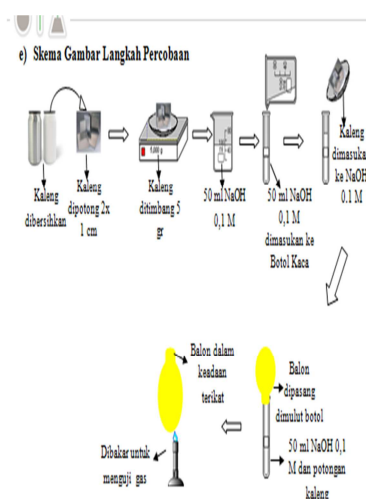


Figure 1. Schematic image

With a drawing scheme, students no longer ask their teacher or coworkers what stages of work the funds / materials should be used.

In addition to this guide also presented how to make solutions, this aims to assist teachers in preparing solutions that will be used. The chemicals used are also from materials that are often used in daily life.

Membuat Larutan Asam cuka (CH_3COOH) 0,1 M

- a. Larutan Asam cuka 0,1 M dari cuka makanan
(kadar asam cuka dapat dilihat pada kemasan cuka makanan)
1. Jika kadar asam sulfat dalam air aki adalah 20% w/v, maka dihitung konsentrasi asam sulfat dalam cuka makanan dengan cara:

$$20\% \text{ w/v} = 20 \text{ gr} / 100 \text{ ml dengan masa jenis asam cuka } 1,05 \text{ g/cm}^3$$

$$\begin{aligned} \text{Maka konsentrasi asam sulfat adalah} \\ = \frac{20 \text{ g} \times 1,05 \text{ ml}}{100 \text{ g}} = 3,5 \text{ M} \end{aligned}$$

Figure 2. Preparation of Solutions

In this guide also displayed laboratory techniques that aim to provide information on how to work in the laboratory.

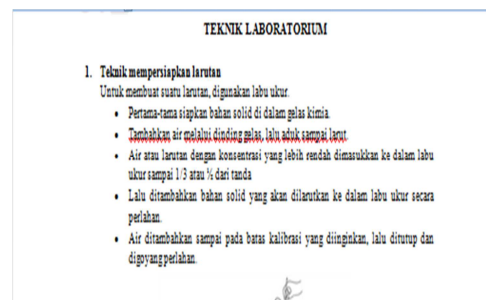


Figure 3. laboratory techniques

This guide also displays pictures of tools and materials, it aims to introduce a tool that will be used in practical activities. In addition to photos / images of the equipment used, a chemical function is also displayed.

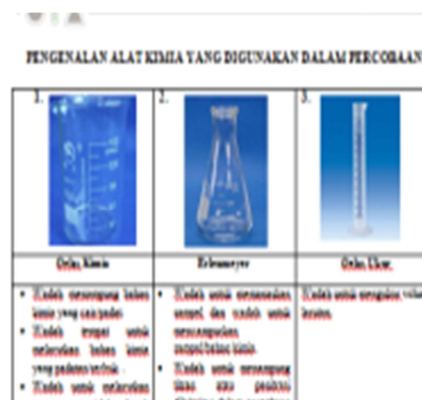


Figure 4. Chemical Tools

The tools and materials used in the guide also present alternative tools and materials, it is intended that practicum activities can take place at schools that do not have labor and equipment and chemicals.

b) Alat

No	Alat	Alternatif Alat	Jumlah
1.	Gelas Kimia	Gelas Kaca	3
2	Gelas Ukur	Gelas takaran Rice Cooker	1
3	Alat Uji Elektrolit		1

c) Bahan

No	Bahan	Bahan Kimia Alternatif	Jumlah
1	H ₂ O	Air	10 ml
2	NaCl 10 %	Lar Garam dapur	10 mL
3	NaOH 10 %	Lar Soda Api	10 mL
4	CH ₃ COOH 0,1 M	Asam Cuka	10 mL
5	Glukosa 10 %	Gula Dapur	10 mL
6	CaO 10 %	Kapur	10 mL
7	Larutan Sabun 10%	Sabun	10 mL

Figure 5. Chemical tools and material

In addition to the alternative tools and materials displayed in this guide, the principles of green chemistry used in each experiment are also displayed and explained

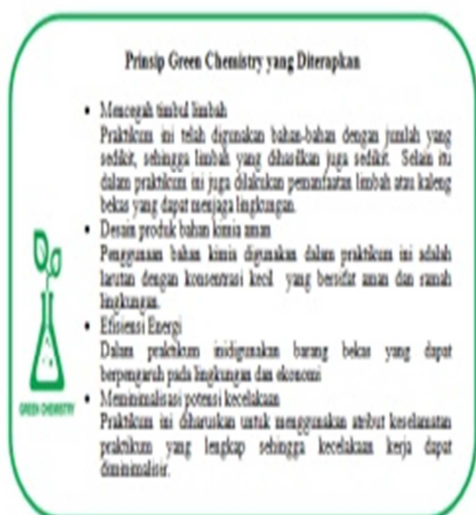


Figure 6. Green Chemistry

In this guide also displayed safety in each experiment, so students know and apply it, so that practicum activities take place safely and accidents at work can be avoided.

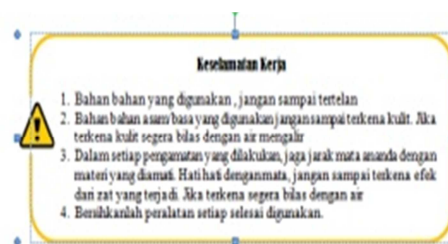


Figure 7. Work safety

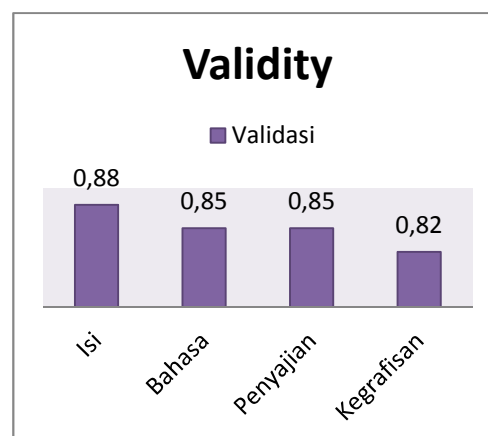
C. Development

1. Validity of the Guide

Measurement of validity of Chemistry Practicum Guides Based on Green Chemistry Class X Even Semester contained in the validation sheet, there are three components that must be assessed in accordance with those contained in the Ministry of National Education (2008: 8) including content, presentation and language components. The assessment data from this validation sheet were then analyzed using the Cohen Kappa formula.

From the data obtained, the average validation results of the Chemistry Practicum Guideline based on Green Chemistry Class X Even Semester of the three validators is 0.85 with a very high validity category. So as such, the results of the Green Chemistry Class X Class Even Even Semester-based Chemistry Practicum assessment developed were valid. A test can be said to be valid if it can reveal the accuracy, truth, validity, or validity by expressing and measuring what should be measured (Latisma Dj, 2011: 82).

Graph 1. Kappa Moment Value (k) for each validation component



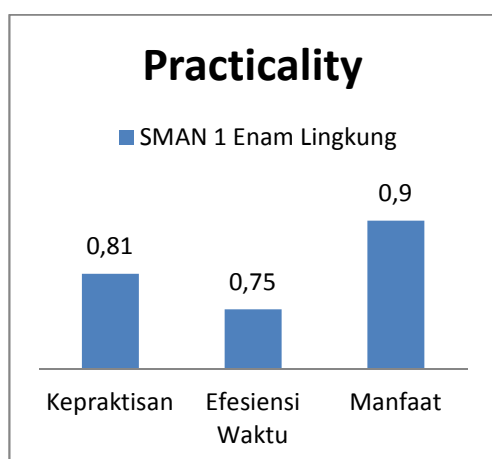
b. Practicality of Guides

Practicality is related to the use of guides that will be used in the chemical practicum process. A guide that is said to be practical if it can be used to carry out practicum logically, comes together without many problems. Practicality considerations can be seen from the aspects of ease, efficiency of time and attractiveness (Sukardi, 2011: 52). Guides are said to be practical if the teacher and the target user (students) assess that the guide can and is easy to use (Plump, 2013: 28).

1. Practicality of the Teacher

In this practicality analysis analysis, the components assessed include ease of use, efficiency of study time, and the benefits of the Chemistry Practicum Guideline based on Green Chemistry Class X Even Semesters that have been developed. The results of practicality test by the teacher, the kappa moment value is obtained for all components of the practicality test by the teacher which is equal to 0.82 with a very high practicality category.

Graph 2. Kappa Moment Value (k) for each component of teacher practicality



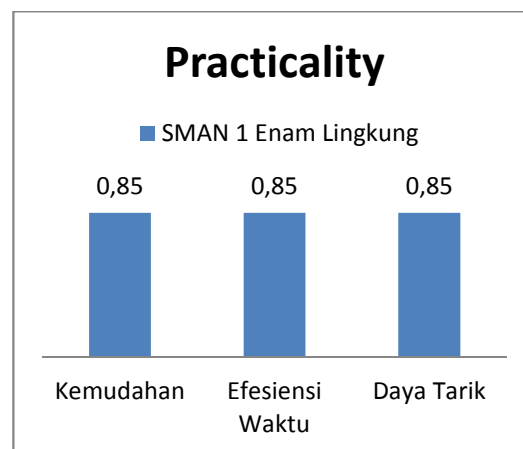
Based on the kappa moment values obtained, this shows the Chemistry Practicum Guideline based on Green Chemistry Class X Even Semester can assist teachers in conveying learning and the teacher acts as a facilitator, helps teachers guide students to understand the subject matter independently, generate student interest in learning, and facilitate students find your own concepts in the learning process.

2. Practicality of Students

Based on the data of practicality test results of guiding chemistry labs based on green chemistry class X even semester, it can be analyzed using the Kappa Cohen formula to obtain kappa moment values. data processing questionnaire responses of these students, can be seen the acquisition of kappa moment

value of 0.85 with a very high practicality category when used in the practicum process.

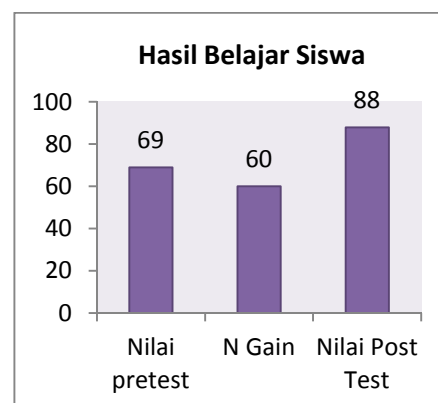
Graph 3. Kappa Moment Value (k) for each component of student practicality



Based on the practicality of students, it was concluded that the guide that was developed could help students in practicing practicum activities to find the chemistry concepts learned, facilitate students in practicing practicum, increase student motivation in practicum and chemistry learning because in the guide there were pictures that could stimulate students. Image stimulus in the guide will give better results in remembering, recognizing, recalling and linking facts with concepts (Aryad, 2013: 12). Charts and colored pictures make the brain more active and increase the enjoyment of students. (Elizar et al, 2013).

C. Effectiveness

In this study, the effectiveness of green chemistry based lab guides is seen from student learning outcomes after the use of guides



From the graph above it was found that student learning outcomes improved after using the lab guide. N-Gain score or percent of both samples. N The gain score obtained at SMAN 1 Enam Lingkung is 0.61. From the N-Gain results obtained, the use of the guide is effective enough in improving student learning outcomes. The difference in learning outcomes is because when students use a green chemistry-based practical guide, students are trained to find concepts independently and build their own knowledge. With the use of this guide, students are guided and trained to work independently, safely and environmentally friendly.

D. Disseminate

At this stage the distribution was carried out to Chemistry teachers in Padang Pariaman Regency.

V. CONCLUSION

This research is a research development that produces green chemistry-based chemistry lab guides for class X even semester. Based on the research that has been done, it can be concluded that chemical chemistry based lab chemists are trained to help the implementation of chemical practicum in the even semester X class.

- a. Green chemistry-based chemistry lab guides produced have a kappa moment of 0.85 with a very high degree of validity.
- b. Green chemistry-based chemistry lab guides have a very high level of practicality than at the field trial stage (fieldtest) having a very high level of practicality from the results of the student response questionnaire 0.83 and teacher response questionnaire 0.85.
- c. The effectiveness of the praktikum guide seen from student learning outcomes found that the chemistry lab guide based on green chemistry was quite effective in improving student learning outcomes at SMAN 1 Enam lingkung with an N-Gain score obtained of 0.60.

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