# Development of an Environment Based Chemistry Practicum Guide for Class XI

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***Abstract.*** *This study aims to determine the feasibility of an environmentally based chemistry practicum guide for class XI and to determine student responses to an environmentally based chemistry practicum guide for class XI. The sample in this study was the class XI students of Senior High School 12 Kupang. The type of research used is R&D research using the Thiagarajan 4D development model which consists of defining, designing, developing, disseminating. Based on the results of the material expert validation, the average percentage of validity was 82.22% with very feasible criteria and the media expert validation obtained an average percentage of validity of 85.625% with very feasible criteria. In the limited trial, the average percentage of student responses to the developed practicum guide was 81.13% with very good criteria. In the extensive trial, the average percentage of student responses to the developed practicum guide was 85.42% with very good criteria.*

***Keywords:*** *development, chemistry practicum guide, environment based*

## INTRODUCTION

One of the appropriate methods used by teachers to encourage student activity as a whole and can meet student learning needs in studying science material is by using the practical method [1]. This practicum method aims to explore students thinking, that learning chemistry can use materials that are easily obtained in everyday life or at home. Students feel happy doing their own practicums, get the concept of material about chemistry by finding it directly according to their learning experience and can better understand abstract things in chemical material through their practicum experiences [2]. Environmentally based experimental methods involve the use of materials that are readily available around students at affordable prices, allowing for continuous experimentation [3].

Practical activities are applications of the theories that have been learned to solve various kinds of problems through experiments in the laboratory. This practicum activity can provide insight to students because it involves students to solve a problem [4]. Practical activities are an essential element of learning because they not only improve students' skills and critical thinking abilities, but also enable them to engage directly in various learning activities that lead to discovery and in-depth understanding of concepts [5]. After students learn a concept, they can prove the truth of the concept by doing practicum. Practical work provides students with the opportunity to be directly involved in the experimental process, from observing objects, analysing and verifying results, to drawing conclusions about the objects being studied. A practicum guide is a book that is prepared to assist the implementation of a practicum which contains procedures for preparation, implementation, data analysis and reporting. The practicum guide can help students in practicum activities. The practicum guide is a practicum facility that has been used for a long time to help and guide students to work in a sustainable and directed

manner because it contains guidelines for the stages of practicum work for students and for the teacher himself. Preparation and guidance such as practical guides have the aim of activating students and assisting students in developing assessment of science process skills [6]. The practicum guide must contain several important components, namely the title of the practicum, the competencies to be achieved, learning instructions, supporting information, work procedures, and the practicum assessment mechanism [7]. With the practicum guide, students can easily and orderly carry out the practicum, and can help teachers to guide students who have difficulty when carrying out the practicum. The practicum guide can direct activities in student-centered learning and encourage students to collaborate and produce scientific products [8].

One of the obstacles to the implementation of practicum in schools is the absence of chemistry practicum guides for class XI and the limited availability of chemical tools and materials in schools. Facing obstacles like this, innovation is needed as a solution to overcome the lack of availability of tools and materials that support practicum. One of the efforts to overcome this is to use an environment-based chemistry practicum module in practicum activities. Environment-based chemistry practicum guides are expected to provide teachers and students with an understanding that conducting chemistry practicals can be carried out by utilizing materials found in the surrounding environment, are easily available and do not require expensive costs [9]. Environment-based practicum guides are a means of supporting the practicum process whose materials can be easily obtained from the surrounding environment. Environment-based chemistry practicum guides on acid-base materials developed are feasible/valid with a percentage of 83%, so they are effectively used in practicum [10].

Based on the above explanation, aims to determine the feasibility of an environmentally based chemistry practicum guide for grade XI and to determine student responses to an environmentally based chemistry practicum guide for grade XI. For this purpose, the researchers developed an environmentally based chemistry practicum module for grade XI through the development stages of the 4D model (*define, design, develop, disseminate*). This practicum guide consists of several materials taught in class XI and in accordance with the class XI syllabus. This developed practicum guide can be used by grade XI students as an alternative teaching material in practicum activities so as to facilitate students when doing practicum at school.

## METHOD

This research was conducted at Senior High School 12 Kupang involving grade XI students as samples. The type of research applied was Research and Development (R&D) through the Thiagarajan 4D model, covering the stages of definition, design, development, and dissemination. Material validation was carried out by one lecturer and one teacher, while media validation involved one lecturer and one teacher. After the product is declared valid or feasible by material expert validators and media experts, product trials are carried out, namely limited trials and broad trials. Furthermore, the distribution or dissemination stage is carried out. In this study, only limited dissemination was carried out. The limited trial in this study was conducted on students of class XI A, XI B, and XI C Senior High School 12 Kupang as many as 9 students, each class was taken 3 students randomly. In the broad trial, 24 students were selected from class XI A, XI B, and XI C Senior High School 12 Kupang, each class was taken 8 students. Students selected for the broad trial were students who were not included in the limited trial.

The dissemination stage is when the product can be distributed and introduced to the wider community beyond the scope of development itself. Several factors that must be considered when disseminating are user analysis, strategy and theme, dissemination time, and selection of dissemination media [11]. This stage is the stage of disseminating products or models through individuals or groups [12]. The dissemination stage in this study was only carried out limited dissemination, namely by disseminating the final product (environmental based chemistry practicum guide class XI) in a limited manner to class XI students of Senior High School 12 Kupang as many as 60 students. The instrument used was a validation sheet containing

assessment criteria to determine the feasibility of chemistry practicum guides and a response questionnaire sheet to determine the response of students. In this study, data were analysed using descriptive statistical techniques to show the validation results from subject matter experts and media using a Likert scale with values ranging from 1 to 4. The scale with a score of 1 to 4 aims to provide flexibility to the validator in assessing the developed practicum guide. Analysis of student responses obtained from student response questionnaires based on aspects of material coverage, presentation, language and suitability of practicum guides with learning using a Likert scale score of 1 to 4. The criteria for interpreting the feasibility of practicum guides and the criteria for the level of student response are presented in tables 1 and 2.

**Table 1. Criteria for Interpreting the Feasibility of the Practicum Guide**

| Percentage (%) | Criteria |
|---|---|
| 81-100 % | Very Feasible |
| 61-80 % | Worth |
| 31-60 % | Not Feasible |
| 0-30 % | Very Unfit |

**Table 2. Criteria for Student Response Level**

| Percentage (%) | Criteria |
|---|---|
| 81-100 % | Very Good |
| 61-80 % | Good |
| 31-60 % | Not Good |
| 0-30 % | Not Very Good |

[13].

## RESULTS AND DISCUSSION

This research on the development of an environmentally based chemistry practicum guide for class XI *IPA* material uses the Thiagarajan 4D development model. The stages of development research consist of *defining*, *designing*, *developing*, and *disseminating*. This study produced an environmentally based chemistry practicum guide on class XI IPA material. Material validation was carried out by 1 lecturer and 1 teacher. While media validation was carried out by 1 lecturer and 1 teacher twice. After the product is declared valid or feasible by material expert validators and media experts, product trials are carried out, namely limited trials and broad trials. Furthermore, the distribution or dissemination stage is carried out. In this study, only limited dissemination was carried out.

### Material Expert Validation

Validation of environmentally based chemistry practicum guides in class XI IPA material on material experts was carried out 2 (two) times with assessment aspects including content quality, presentation and language. After the material expert sees and reads the environment-based chemistry practicum guide in class XI IPA material designed by the researcher. Furthermore, the material expert assesses the environment-based chemistry practicum guide in class XI IPA material using a validation sheet. From the results of the validation, suggestions and improvements were obtained for the environment-based chemistry practicum guide in class XI IPA material developed. The results of the second validation from material experts are presented in table 3 and 4.

**Table 3. Recapitulation of Second Validation Results from the First Material Expert**

| Aspects | Total Score Obtained Per Aspect (ΣX) | Total Maximum Score Per Aspect (ΣXi) | Validity Percentage Per Aspect (P) (%) | Criteria |
|---|---|---|---|---|
| Content Quality | 20 | 24 | 83.33 | Very Feasible |
| Presentation | 16 | 20 | 80 | Worth |
| Language | 16 | 20 | 80 | Worth |
| Average Percentage (%) | | | 81.11 | Very Feasible |

From the results of the first material expert validation, the average percentage of validity (feasibility) was 81.11% with very feasible criteria. In each aspect, the percentage of validity obtained is in the aspect of content quality of 83.33% with very decent criteria, in the aspect of presentation of 80% with decent criteria, and in the aspect of language of 80% with decent criteria.

**Table 4. Recapitulation of the Second Validation Results from the Second Material Expert**

| Aspects | Total Score Obtained Per Aspect (ΣX) | Total Maximum Score Per Aspect (ΣXi) | Validity Percentage Per Aspect (P) (%) | Criteria |
|---|---|---|---|---|
| Content Quality | 18 | 24 | 75 | Worth |
| Presentation | 17 | 20 | 85 | Very Feasible |
| Language | 18 | 20 | 90 | Very Feasible |
| Average Percentage (%) | | | 83.33 | Very Feasible |

From the results of the validation of the second material expert, an average percentage of validity (feasibility) of 83.33% was obtained with very feasible criteria. In each aspect, the percentage of validity obtained is in the content quality aspect of 75% with decent criteria, in the presentation aspect of 85% with very decent criteria, and in the language aspect of 90% with very decent criteria. The average percentage of validity (feasibility) from the first material expert and the second material expert is presented in table 5.

**Table 5. Recapitulation of Second Validation Results from the First Material Expert and Second Material Expert**

| Aspects | Average Validity Percentage Per Aspect (P) (%) | Criteria |
|---|---|---|
| Content Quality | 79.17 | Worth |
| Presentation | 82.5 | Very Feasible |
| Language | 85 | Very Feasible |
| Average Percentage (%) | 82.22 | Very Feasible |

This environment based chemistry practicum guide on the material of class XI IPA developed is very feasible to be used by students of class XI IPA. This can be seen based on the results of the second validation of the first material expert and the second material expert obtained an average percentage of validity (feasibility) of 82.22%. The results of the development of the practical guide, which has been validated by experts, show that the material is suitable for use in the learning process. The three main aspects tested in this validation are content/material suitability, appearance, and language. Each aspect plays an important role in determining the extent to which this practical guide can support student understanding [14].

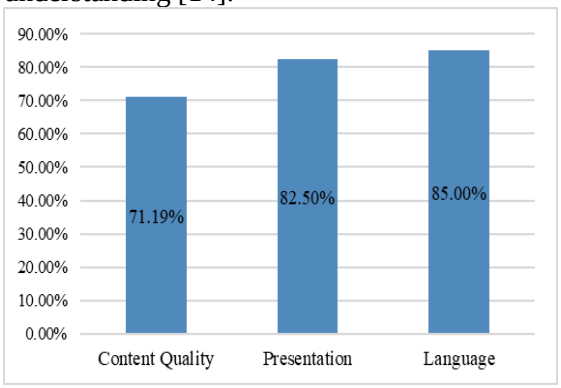


**Figure 1. Validation Tabulation of First Material Expert and Second Material Expert**

## Media Expert Validation

Validation of environmentally based chemistry practicum guides in class XI IPA material on media experts was carried out 2 (two) times with assessment aspects including appearance and use of letters and spaces. After the media expert sees and reads the environment-based chemistry practicum guide in class XI IPA material designed by the researcher. Furthermore, media experts assessed the environment-based chemistry practicum guide in class XI IPA material using a validation sheet. From the results of the validation, suggestions and improvements were obtained for the environment-based chemistry practicum guide in class XI IPA material developed. The results of the second validation from media experts are presented in tables 6 and 7.

**Table 6. Recapitulation of Second Validation Results from the First Media Expert**

| Aspects | Total Score Obtained Per Aspect (ΣX) | Total Maximum Score Per Aspect (ΣXi) | Validity Percentage Per Aspect (P) (%) | Criteria |
|---|---|---|---|---|
| Tampilan | 18 | 24 | 75 | Worth |
| Use of fonts and spacing | 18 | 20 | 90 | Very Feasible |
| Average Percentage (%) | | | 82.5 | Very Feasible |

The validation results from the first media expert showed that the average validity percentage reached 82.5%, which is classified as highly valid. In each aspect, the percentage of validity obtained is in the display aspect of 75% with decent criteria and in the aspect of using letters and spaces of 90% with very feasible criteria.

**Table 7. Recapitulation of Second Validation Results from Second Media Expert**

| Aspects | Total Score Obtained Per Aspect (ΣX) | Total Maximum Score Per Aspect (ΣXi) | Validity Percentage Per Aspect (P) (%) | Criteria |
|---|---|---|---|---|
| Tampilan | 21 | 24 | 87.5 | Very Feasible |
| Use of fonts and spacing | 18 | 20 | 90 | Very Feasible |
| Average Percentage (%) | | | 88.75 | Very Feasible |

From the validation results of the second media expert, the average percentage of validity (feasibility) is 88.75% with very feasible criteria. In each aspect, the percentage of validity obtained is in the display aspect of 87,5% with very feasible criteria and in the aspect of using letters and spaces of 90% with very feasible criteria. The average percentage of validity (feasibility) from the first material expert and the second material expert is presented in table 8.

**Table 8. Recapitulation of Second Validation Results from First Media Expert and Second Media Expert**

| Aspects | Average Validity Percentage Per Aspect (P) (%) | Criteria |
|---|---|---|
| View | 81.25 | Worth |
| Use of fonts and spacing | 90 | Very Feasible |
| Average Percentage (%) | 85.625 | Very Feasible |

This environment based chemistry practicum guide on the material of class XI IPA developed is very feasible to be used by students of class XI IPA. This can be seen based on the results of the second validation of the first media expert and the second media expert obtained an average percentage of validity (feasibility) of 85.625%. Practical guides facilitate students in conducting practical work so that practical activities can run smoothly and in a focused manner [15].

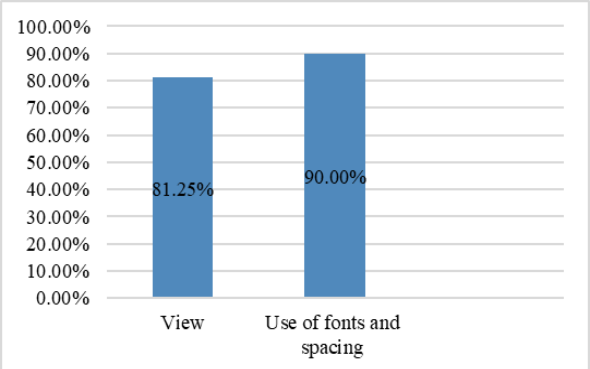


**Figure 2. Validation Tabulation of First Media Expert and Second Media Expert**

## Limited Trial

After the developed practicum guide is declared feasible or valid, a product trial is carried out, namely a limited trial. The limited trial was conducted on students of class XI A, XI B and XI C SMA Negeri 12 Kupang as many as 9 students, each class was taken 3 students randomly. The data collection instrument used in the limited trial used a student response questionnaire sheet. The results of the recapitulation of student response

questionnaires to the developed practicum guides (aspects of material coverage, presentation, language, and suitability of practicum guides to learning) in the limited trial are presented in table 9.

**Table 9. Recapitulation of Student Response Questionnaire Results on Limited Trial**

| Assessed Aspect | Assessment Results | |
|---|---|---|
| | Percentage (%) | Criteria |
| Material coverage | 81.48 | Very Good |
| Presentation | 83.33 | Very Good |
| Language | 77.78 | Good |
| Suitability of Practicum guide with learning | 81.94 | Very Good |
| Average Percentage (%) | 81.13 | Very Good |

Based on table 9, the average percentage of student responses to the environmental-based chemistry practicum guide for class XI in the limited trial was 81,13% with very good criteria. This study shows that well-structured practical guidelines can effectively support students in realising their abilities and understanding the practical process [16].

From the results of this response questionnaire, students stated that the work procedures contained in the developed environment-based chemistry practicum guide were easy to understand, the language used was easy to understand and the materials used were easily found in everyday life, but there were suggestions from students for improving the environment-based chemistry practicum guide. The student suggestions for the developed practicum guide are to improve the typing of the writing because there are still typing errors in the developed practicum guide.

**Figure 3. Limited Trial**

## Extensive Trial

After the limited trial, a broad trial was conducted. In this broad trial, 24 students were selected from classes XI A, X B, and X C of Senior High School 12 Kupang and each class was taken 8 students. Students selected for the broad trial were students who were not included in the limited trial. In the large scale trial, data was collected using student response questionnaires. A summary of the assessment results for the practice guidelines (covering material, presentation, language, and suitability for the learning process) is presented in Table 10.

**Table 10. Recapitulation of the Results of Student Response Questionnaire on the Extensive Trial**

| Assessed Aspect | Assessment Results | |
|---|---|---|
| | Percentage (%) | Criteria |
| Material coverage | 85.42 | Very Good |
| Presentation | 82.29 | Very Good |
| Language | 85.42 | Very Good |
| Suitability of practicum guide with learning | 88.54 | Very Good |
| Average Percentage (%) | 85.42 | Very Good |

Based on table 10, the average percentage of student responses to the environment-based chemistry practicum guide for Grade XI in the large-scale trial stage reached 85.42%, which is classified as excellent. Based on the questionnaire analysis results, students assessed that the visual design of the chemistry practicum guide was attractive and that the content was presented clearly and was easy to understand. The implementation of the practicum guide, which had undergone a validation and testing process, was assessed as being able to increase student engagement in learning activities and support their understanding of the concepts to be practiced [17]. Through environment-based practical activities, students can develop observation, analysis, and synthesis skills [18]. The provision of practical support tools in the form of practical guides can assist teachers in conducting practical activities and overcoming the incompatibility of the tools and materials available in the laboratory with the practical requirements [19].

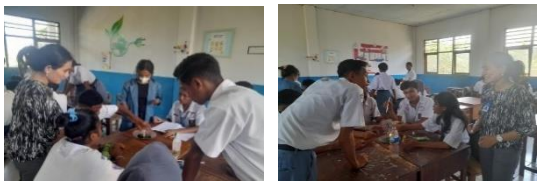

**Figure 4. Extensive Trial**

**Deployment Stage**

After the product trials (limited trials and extensive trials) and the instruments were revised, the research process continued to the dissemination stage. This stage aimed to implement and disseminate the environment-based chemistry practicum guidelines to Year 11 students. In this study, only limited dissemination was carried out, namely by disseminating the final product (environmental based chemistry practicum guide for class XI) on a limited basis to class XI students of Senior High School 12 Kupang as many as 60 students. Students gave an assessment of the chemistry practicum guide that had been developed through a student response questionnaire. A summary of the results of the student response questionnaire regarding the developed practical guidelines covering aspects of material coverage, presentation, language, and the suitability of the practical guidelines to the learning process at the dissemination stage is shown in Table 11.

**Table 11. Recapitulation of Student Response Questionnaire Results at the Deployment Stage**

| Assessed Aspect | Assessment Results | |
|---|---|---|
| | Percentage (%) | Criteria |
| Material coverage | 85.42 | Very Good |
| Presentation | 82.29 | Very Good |
| Language | 85.42 | Very Good |
| Suitability of practicum guide with learning | 88.54 | Very Good |
| Average Percentage (%) | 85.42 | Very Good |

**Figure 5: Deployment Stage**

Based on Table 11, the average percentage of student responses to the environment-based chemistry practicum guide for Grade XI at the dissemination stage reached 88.13%, which is classified as excellent. From the results of this response questionnaire, students stated that the developed practicum guide made it easier for students when doing practicum and the use of chemistry practicum guides could increase students' interest in learning. Based on the above description, the environment-based chemistry practicum guide for Grade XI is deemed suitable and appropriate for use by Grade XI students. The findings of this study are consistent with the results of study [20], which explains that a practical guide is a book compiled to facilitate the implementation of practical activities, containing experiment titles, objectives, theoretical basis, lists of tools and materials, as well as questions that guide students towards achieving objectives by following scientific writing rules. The results of this study are also in line with research conducted by [21] which explains that practical guidance in practical learning has a positive influence in optimizing students' acquisition of knowledge and learning experience.

## CONCLUSION AND SUGGESTIONS

**Conclusion**

The feasibility test results show that the validation process by subject matter experts produced an average percentage of 82.22%, which is categorised as highly feasible. In addition, the validation results by media experts obtained an average percentage of 85.625%, which is also in the highly feasible category.. In the limited trial, the average percentage of students' response to the environment-based class XI chemistry practicum guide was 81.13% with very good criteria. In the broad trial, the average percentage of students' responses to the environment-based chemistry

practicum guide for class XI was 85.42% with very good criteria. At the dissemination stage, the student response to the environmentally based class XI practicum guide was 88.13% with very good criteria. The environment based chemistry lab manual for grade XI is suitable for use by grade XI students in chemistry learning.

**Suggestion**

Suggestions for further researchers are to be able to develop an environment-based chemistry practicum guide for grade X and XII students up to the dissemination stage.

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