

Validation of Environmental Chemistry Students' Worksheet Based on The Mangrove Ecosystem to Pre-Service Students'

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Abstract

This study aims to produce a worksheet enriched with the local wisdom mangrove ecosystem under a valid category. The research method executes by R&D with the focus outlined in the validation of student worksheets based on mangrove ecosystems. The instruments were a validation sheet filed by 4 experts in chemistry and education and a questionnaire. Validation is carried out through discussion with the research team about the feedback and suggestions to correct the improvements and direct improvements in assessing students' worksheet (LKM). This research found that the students' worksheet based on the mangrove ecosystems was valid, readability, and ready to use in field trial learning.

Keywords: Environmental Students' Worksheet; Chemistry Students' Worksheet; Mangrove Ecosystems; Chemistry Pre-service Student

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INTRODUCTION

Facing rapid development in the 21st century, critical thinking skills are valuable for study. The results of previous studies indicate that chemistry is often ranked as the most difficult subject at all levels of education (Wahyudiati, 2022). Therefore, understanding chemistry in its representative and symbolic nature is one of the basic skills that students should have to develop their critical thinking skills (Sombria et al., 2023). Chemistry learning must be designed using innovative models and tools. The development of learning tools is very important because it supports the learning process (Saija et al., 2021). The students' worksheet (for pre-service students, we called it LKM) is one of them that supports media learning (Saija & Beay, 2022). The use of student worksheet will support understanding of the real

world when using learning strategies to achieve a main goal. Eilks et al., (2018) added that conceptual understanding material may be easier to build with demonstration assistance, especially that visualizing abstract concepts and making it as concrete as possible.

Further, based on the results of the analysis of the journal, it has been found that several development studies have been carried out previously and concluded that environment based worksheets have succeeded in improving chemistry learning outcomes. These studies were carried out on chemistry topics with certain local wisdom, namely inorganic chemistry (Ekaputra & Widarwati, 2023); tea plant to asses environmental literacy (Wahyuni et al., 2022); water purification (Sukardi et al., 2022) also succeeded in developing student worksheets. Therefore, the focus of this

research is to develop environmental chemistry students' worksheet based on the mangrove ecosystem.

In reality, chemistry is less relevant (Eilks & Hofstein, 2015) as the fundamental factor researchers use in the local potential of mangrove ecosystems in the development of this students' worksheet. The use of local potential is interesting because it can motivate students to understand the context of science and chemical content/material. This can be concluded based on the results of initial observations made by researchers. Most students think that studying chemistry is too difficult and not useful for their future life. In addition, the limitations experienced so far are related to the effectiveness of laboratory use due to a shortage of practicum tools and materials. Chemistry education reform is important to do with all the limitations that exist. Forbes et al., (2020); Pamungkas et al., (2017); Setiawan (2020); Widianingsih (2019) emphasize learning that supports the flexibility of local characteristics, both in the curriculum for the effectiveness of science learning. The local potential is empowered in chemistry learning as an effort to overcome existing limitations.

Previous research shows the benefits of using local potential in students' worksheet can facilitate understanding of concepts, motivate, and increase learning awareness (Amila et al., 2018; Irawati & Sofianto, 2019; Simamora & Saragih, 2019). Previously developed students' worksheet were not based on Maluku's local wisdom. Even though there are so many local potentials that can be used to make chemistry more relevant to real life, they have not been utilized during the learning process. The application of local potential in LKM can be in the form of contexts, pictures, and examples that are adapted to the learning conditions, characteristics, and needs of students. Therefore, this research purpose is to develop learning resources in the form of student worksheets based on the mangrove ecosystem to improve pre-service students' critical thinking skills under a valid category.

RESEARCH METHODE

The development of environmental chemistry students' worksheet based on the mangrove ecosystem is based on student needs and the study of learning theories. The research is done by R & D methods with 4 steps.

Procedure and Research Design

This research was carried out in several ways stages, namely: 1) Planning, at this stage to design and develop the environmental chemistry students' worksheet based on the mangrove ecosystem; 2) expert validation with 4 experts by chemistry and chemistry education; 3) Small scale trial with 10 pre-service students' of chemistry environment class; and 4) Large study group with all pre-service students' of chemistry environment class.

Research Sample

The sample of this research was 28 pre-service students' of the chemistry environment class Department Chemistry Education Universitas Pattimura.

Instrument and Data Analysis

The development of the environmental chemistry students' worksheet based on the mangrove ecosystem uses an expert validation sheet and readability questionnaire. The expert validation uses a validation sheet with two parts, namely: the statements with four options to aspects of the content (shown in Table 1) of contains, language, and design; and spaces in which they should write down comments.

The readability questionnaire contains 12 questions and spaces in which they should write down comments about the environmental chemistry students' worksheet based on the mangrove ecosystem. Then, the data was analyzed using descriptive analysis techniques.

Table 1. Expert Rating Table

No	Assessment Aspects	Rating Scale				
		1	2	3	4	5
	Contain					
I	Students' worksheet is arranged according to the learning objectives					
	Students' worksheet is arranged systematically according to the order of the material and the sequence of students' thinking					
	Students' worksheet contains guiding questions for students' understanding of the material being studied in accordance with the learning objectives					
	Accuracy in the use of formula symbols/symbols and writing reaction equations					
II	Language					
	Students' worksheet is prepared using Indonesian properly and correctly					
	Students' worksheet is arranged using communicative sentences					
	Students' worksheet is arranged using sentences that are clear and easy to understand					
III	Design					
	The suitability of the image illustrations with the topic					
	Layout settings suitability					
	Display attracts enthusiasm and motivation of students to solve problems					
	Visually attractive appearance					
	Appropriate use of fonts					
	Appropriateness of the use of font size					

RESULT AND DISCUSSION

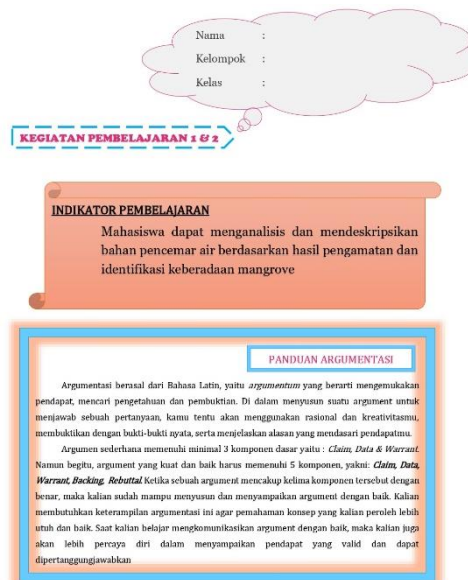
The results of the data analysis of validation results by experts are shown in Table 2.

Table 2. Expert Validation Result

Component	Average Score (%)	Category
Content	90.35	Very Valid
Language	85.45	Valid
Design	85.45	Valid
Average	87.08	Very Valid

Table 2 shows that the average score for all aspects belonged to the 'very valid' category, which

means that the students' worksheet is valid. The data shown in Table 2 are the results obtained after the researchers revised some parts of the students' worksheet, as suggested by the expert. The revisions included cover design, image display, colour, font, and the contents of the students' worksheet based on the local wisdom mangrove ecosystem. And part of the content about benefit mangrove for example as a phytoremediation.



Picture 1. A Cover and Part of Contain of Students' worksheet Based On Mangrove Ecocystem

In terms of language, several students thought that the students' worksheet language is easy to understand. This is reasonable because the speed of reading comprehension depends on the speed of the student's ability to understand. It seems that the student's ability is relatively different in language comprehension in the students' worksheet. However, some terms gave a clearer explanation. Diction and sentence compilation this is very important for printed learning materials because they pay a lot of communication ability

(Siswanto (2018); Sudarmin et al., (2019); Sumardi (2019)).

Then, the environmental chemistry students' worksheet based on the local wisdom mangrove ecosystem was piloted in two stages, namely small-scale trials and large study group. The results of small scale trial on the use of the environmental chemistry students' worksheet based on the mangrove ecosystem with a value of 3.7 "very good" (Lestari et al., 2019) show that it can be used in the actual research class. The results are shown in Table 3.

Table 3. Students Response Result

No	Question	Score Average
1	Can you understand the steps in this worksheet?	3,9
2	Are the contents of the material in the worksheet clear and understandable?	3,8
3	Does the display of worksheet (writings, pictures, tables) can help you learn?	3,5
4	Can you understand the language of the worksheet?	3,4
5	Are the problems of the worksheet relating to the problem of everyday life?	3,9
6	Do the learning activities in worksheets help you understand the content of the material being taught?	3,8
7	Can you solve the problems in the worksheet individually or in groups?	3,5
8	Are the problems in the worksheet challenge your thinking?	3,8
9	Are the questions on the worksheet encourage you to cooperate and to discuss?	3,8
10	Are the mangrove ecosystem you make to help you learn?	3,9
11	Do "go-enjoy" activities make you more aware of learning?	3,9
12	Are you happy to complete every task you need to work on in the worksheet?	3,4
TOTAL		3.7

The established students' worksheet are equipped with socioscientific issues as a context is "Mangrove vs Polutan PLN" it shown in Picture 2.

LKM berbasis Ekosistem Mangrove 2

1. Fase I : Orientaton to SSI

SOCIOSCIENIFIC ISSUE (SSI)

adalah isu-isu yang ada disekitar kita dan berhubungan dengan aplikasi dari materi yang kita pelajari. Aplikasi materi yang kita pelajari ini mempunyai dampak positif dan negatif sehingga menimbulkan dilema bagi masyarakat.

- Perhatikan video yang ditayangkan oleh guru.
- Bacalah wacana SSI berikut, kemudian pikirkanlah jawaban atas pertanyaan yang muncul dalam wacana tersebut.

"MANGROVE VS POLUTAN PLN"

Secara umum, berbagai jenis pohon mangrove mempunyai kandungan konsentrasi logam berat yang rendah sekalipun berada pada habitat yang terkontaminasi dengan unsurunsur logam berat tersebut. Oleh karena itu, pohon mangrove bukan merupakan bioindikator yang baik dari ekosistem yang terkontaminasi oleh logam berat. Hal ini diperkuat oleh penelitian yang dilakukan oleh Silva et al. (1990) di Sepetiba Bay, Rio de Janeiro yang mengemukakan bahwa walaupun sedimen habitat mangrove mengandung 99% Mn dan Cu serta hampir 100% Fe, Zn, Cr, Pb dan Cd tetapi jaringan tumbuhan *Rhizophora mangle* mengandung < 1% dari total konsentrasi logam berat tersebut. Begitu pula dilaporkan oleh Siddiqi and Zaidi (1994) yang melakukan penelitian di Pantai Saudi Arabian Gulf bahwa tidak ada korelasi antara konsentrasi logam berat di sedimen dengan

LKM berbasis Ekosistem Mangrove 3

konstraksi logam berat di daun mangrove yang hidup pada tanah yang terkontaminasi logam berat.

Lsitrik sangat dibutuhkan oleh masyarakat. Dengan berdirinya Perusahaan Listrik Negara (PLN) di suatu wilayah, maka pertumbuhan ekonominy akan berubah menjadi lebih baik. Namun, di teluk Ambon (khususnya) beberapa hutan mangrove terkontaminasi limbah dari PLN. Tumbuhan mangrove terancam di habitatnya sendiri, bahkan keanekaragaman hayati yang ada di hutan mangrove pungkut terancam. Pentingkah untuk menghentikan PLN dengan segala aktivitasnya ataukah menrelakan hutan mangrove punah dengan sendirinya?

Picture 2. Example SSI Context

CONCLUSION

This study concluded that the established environmental chemistry students' worksheet based on the local wisdom mangrove ecosystem is useful in the actual research class. The incorporation of environmental, socioscientific context, and ethnoscience has been proven effective in assisting the students to be actively involved in the learning process, cultivate conservational characters, and increase the students' conceptual mastery on the water pollution. The researchers wish that pre-service teacher could employ the developed students' worksheet as a teaching-learning aid on the chemistry class.

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