



Development of Textbooks to Support Merdeka Curriculum Learning on Green Chemistry Material in Phase E

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Abstract: This research aims to develop textbooks to support Merdeka curriculum learning on green chemistry material in phase E. The Plomp development model was utilized in the study method known as Educational Design study (EDR). A validation questionnaire sheet and a practicality questionnaire sheet were used to collect the data. The research results using Aiken's V formula showed that the five validator tests obtained a score in the valid category with a validity value of 88%. In contrast, the practicality test results for students had a value of 91% in the very practical category. The results for chemistry teachers had a value of 96% in the very practical category. According to the research data gathered, phase E-textbooks for the Merdeka curriculum fit under valid and practical categories.

Article History

Received: 12-05-2023
Revised: 15-06-2023
Accepted: 26-06-2023
Published: 17-07-2023

Key Words:

Textbooks; Merdeka
Curriculum; Green
Chemistry; Phase E.

How to Cite: Amanda, F., Mawardi, M., & Suryani, O. (2023). Development of Textbooks to Support Merdeka Curriculum Learning on Green Chemistry Material in Phase E. *Jurnal Paedagogy*, 10(3), 635-645. doi:<https://doi.org/10.33394/jp.v10i3.8126>



<https://doi.org/10.33394/jp.v10i3.8126>

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Introduction

The post-Covid-19 pandemic in Indonesia resulted in teaching and learning activities being carried out online and significantly changed teaching and learning activities for teachers and students. The difficulties or learning crisis after the Covid-19 pandemic resulted in the emergence of learning loss (Kaffenberger, 2021; Winata & Mawardi, 2021). Changes in the field of education pose new problems that must be quickly resolved so that learning activities continue to run effectively, and one of the solutions applied is to change the curriculum (Khairunnisak et al., 2023; Syafei & Mawardi, 2022). Therefore, it is necessary to change the curriculum to adjust to the existing circumstances (Faiz et al., 2022). In response to this crisis, the government tried to improve it by implementing a new curriculum, namely the Merdeka curriculum.

The Merdeka curriculum has been inaugurated starting in the 2022/2023 academic year by the Ministry of Education, Culture, Research and Technology (Kemendikbud, 2022). The Merdeka Curriculum means independence in learning, namely providing learning opportunities as freely and comfortably as possible for students without pressuring children to acquire or master a subject outside of their interests and skills (Sudarma, 2021).

An important concern for the Government of the Republic of Indonesia is to provide adequate facilities and infrastructure as quickly as possible to face global developments (Indarta et al., 2022). One of them is textbooks that are still incomplete to implement Merdeka learning (Angga et al., 2022). Learning in the 21st century must incorporate technology mastery, literacy, information, skills, and attitudes (Mawardi & Fitriza, 2019). The availability of textbooks is essential for students to face the challenges of learning in the 21st century (Sholikha & Fitrayati, 2021). While the problem that exists in some textbooks is that there are still many books that display black and white illustrations and use language that students do not easily understand, so an innovative learning resource that is easy to



understand is needed which contains attractive illustrations or images that can increase students learning motivation (Fitriya, 2018). The multiple representation models in chemistry learning consist of macroscopic representation, sub-microscopic and algebraic representations (Ismail & Mawardi, 2021; Mawardi & Fitriza, 2019).

Using data from a field observation survey that included conducting interviews with chemistry teachers from three different schools, SMAN 1 Padang, SMAN 8 Padang, and SMA Pembangunan Labor UNP, it was discovered that the Merdeka curriculum book currently circulating presents less explicit material contained in the book, especially in green chemistry material. The green chemistry material presented needs to be more coherent, and all students need more writing to digest the contents of books. In addition, textbooks should be made by presenting many varied images and colors so that students can better understand the material and attract more students reading interest.

The decree of the Ministry of Education and Research Number 008/H/KR/2022 regarding chemistry learning outcomes in phase E is green chemistry material (Kemendikbudristek, 2022). Green chemistry is the latest trend in science chemistry because it can reduce hazardous materials in the process of use and production (Wahyuningsih & Rohmah, 2017). Green chemistry efforts are made to reduce, replace, and eliminate the use of toxic chemicals to reduce pollutants. Therefore, green chemistry is a great opportunity for chemistry learning (Inayah et al., 2022).

Research conducted by Wulan (2019) on the development of green chemistry textbooks to improve student learning outcomes shows valid and practical results. In line with the research of Shamuganathan & Karpudewan (2017), students who are taught green chemistry through experiments become more concerned about the environment. Based on the problems described above, researchers were interested in developing textbooks to support the Merdeka learning curriculum enriched with more comprehensive material content and more varied and colorful illustrations expected to attract students reading interest and support the Merdeka curriculum learning process.

Research Method

This study's research method was development research or educational design research (EDR) (Fani & Mawardi, 2022; Nieveen & Folmer, 2013). The end products of this study's work take the form of textbooks that help students understand the phase E green chemistry content of the Merdeka Curriculum (Miftah & Mawardi, 2021).

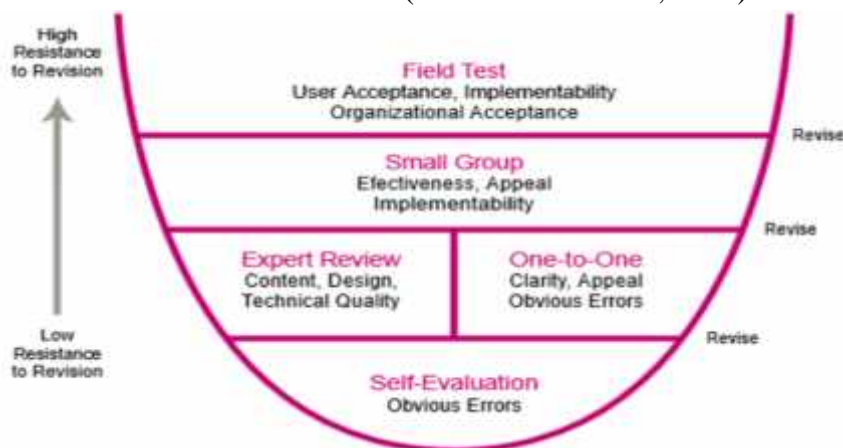


Figure 1. Layers of formative evaluation from Tessmer



The preliminary research stage is the initial stage of the research process. At this point, a needs analysis, context analysis, literature review, and conceptual framework will all be conducted (Nieveen & Folmer, 2013; Siregar & Mawardi, 2022). The steps are as follows:

Need and Context Analysis

The needs analysis stage was carried out by conducting observations by interviewing several chemistry teachers, which aims to find out the basis of the problem or description of the problems and perceptions faced by educators and students in the field as well as during the implementation of the learning process related to textbooks to support Merdeka curriculum learning on green chemistry material in schools. After the needs analysis, the next stage was context analysis. An evaluation of the curriculum and syllabus was done at this point. Context analysis was done to analyze, describe, and methodically gather the range of learning objectives, resources, and techniques selected for creating coursebooks.

Literature Review

Literature study is the theoretical basis of interventions related to development research conducted to find solutions to problems teachers and students face through scientific articles and analyzing journals.

Development of Conceptual Framework

The needs and context analysis and literature study that have been conducted are the basis for developing a conceptual framework. In order to create textbooks that will complement Merdeka curriculum lessons on green chemistry materials, it is necessary to link difficulties or problem identification generated from needs analysis and context analysis with literature studies.

Development or Prototyping Phase

There are four prototyping steps: self-evaluation, expert review, one-to-one evaluation, and small group. The prototype phase produces prototype I, prototype II, prototype III and prototype IV, which are the results of formative evaluation (Kalmar Nizar & Mawardi, 2018; Nieveen & Folmer, 2013)

The data collection techniques used were questionnaires and interviews. The validation questionnaire was addressed to 5 experts: three lecturers and two teachers. At the same time, the practicality questionnaire is addressed to students. The questionnaire was used as a form of reference for assessing the feasibility of the product developed. Aiken's validity index, used in the validity analysis technique, can be used to examine the data's validity. For determining the outcomes of the evaluation provided, a validity sheet in the form of a questionnaire was given at the end of the questionnaire. Using Aiken's validity formula, the validator's evaluation was performed as follows:

$$v = \frac{S}{n(c - 1)}$$

Description:

S = The score assigned by the validator minus the lowest score of the category used

n = Total number of validators

c = Number of categories chosen by the validator

The validity criteria for coursebooks to support Merdeka curriculum learning on green chemistry material for Phase E based on the Aiken validity index are in the following table:



Table 1. Aiken validity index criteria 5 Validators

Aiken V Scale	Description
V 0,80	Valid
V < 0,80	Not Valid

Source: (Aiken, 1985)

The learner response questionnaire yields the assessment of the practicality sheet, which is then assessed using the modified formula from (Ngalim Purwanto, 2014) as follows:

$$NP = \frac{R}{SM} \times 100$$

Description:

NP = Percent value sought or expected

R = Raw score obtained by students

SM = Ideal maximum score of the test concerned

100 = Fixed number

After being divided into the categories in the table below, it will be possible to determine the practicality textbooks are for supporting Merdeka curriculum study.

Table 2. Criteria for the level of practicality

Value	Aspect Assessed
86% - 100%	Very Practical
76% - 85%	Practical
60% - 75%	Quite Practical
55% - 59%	Less Practical
54%	Not Practical

Source: (Yunus & Sardiwan, 2018)

Results and Discussion

Preliminary Research

Needs analysis

In the needs analysis stage, researchers interviewed three chemistry teachers in three different schools in Padang City, namely SMAN 1 Padang, SMAN 8 Padang and UNP Laboratory Development High School. Based on the results of structured interviews conducted with the three chemistry teachers, the results obtained related to Merdeka curriculum learning are that teachers and students need textbooks that can support the learning process that contains complete book content or detailed and coherent material content, various activities or activities support students to understand better the material and the presentation of books using many colors and also varied images that provide an attractive appearance and the use of language that students easily understand.

Context analysis

The curriculum and learning outcomes (CP) are analyzed at the context analysis stage. This analysis aims to identify, detail, and organize the scope of learning objectives, materials, and strategies systematically selected to develop textbooks. It is then derived from the CP into TP and ATP on green chemistry material, which will be compiled in textbooks. Decree of the Ministry of Education and Culture Number 008/H/KR/2022 regarding chemistry learning outcomes in phase E there is green chemistry material (Kemendikbudristek, 2022).



Literature review

After going through the interview stage in the field, the researchers will conduct a literature study of several scientific journals related to the problems found and try to find solutions to the problems encountered. These articles are used as reading sources containing the project idea's source. Based on the literature study conducted, developing textbooks on green chemistry material is one of the efforts made to solve the problems encountered. The availability of textbooks is essential for students to face the challenges of learning in the 21st century (Sholikha & Fitrayati, 2021). According to Sungkono (2009), to make learning more efficient and effective and not deviate from the competencies to be achieved, the development of textbooks will greatly help teachers.

Development of conceptual framework

Based on the review of the literature study that has been carried out, a solution to the identified problems was found. Then a conceptual framework was developed by linking the identified problems as a reference in developing textbooks to support Merdeka curriculum learning in green chemistry material as follows:

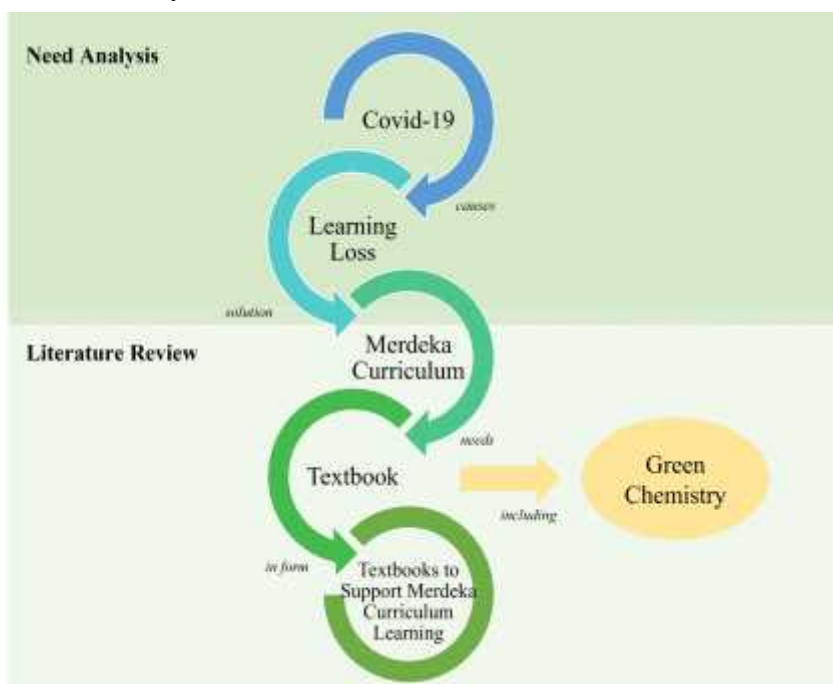


Figure 2. Conceptual Framework

Development phase or prototype

Prototype I

Preliminary research results in the creation of prototype I. The result of Prototype I was the design of textbooks that support Merdeka curriculum learning on green chemistry material with complete and systematic or coherent textbook components and material content. The book component was equipped with a preface, table of contents, learning outcomes (CP), learning objectives (TP), concept map, instructions for using the book, material content, Profil Pelajar Pancasila, keywords, activities, comprehension tests, end-of-book exercises, summary, reflection, bibliography, glossary, index, and answer key. The following is the cover, Profil Pelajar Pancasila, cover book chapter and comprehension test of the textbook:

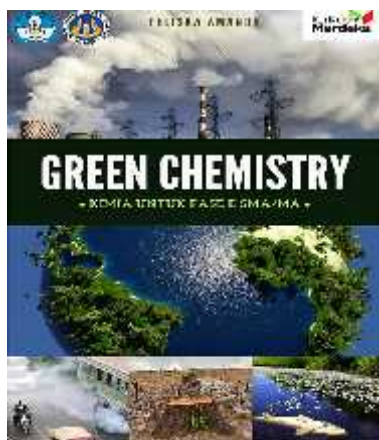


Figure 3. Cover of the book



Figure 4. PROPELA



Figure 5. Cover book chapter



Figure 6. Instructions using



Figure 7. Activities



Figure 8. Comprehension test

Prototype II

The outcomes of the prototype I will then be formatively evaluated by conducting a self-evaluation of prototype I. At this stage of self-evaluation, researchers make corrections and review the completeness of the coursebook components to support Merdeka curriculum learning on green chemistry material using an instrument that takes the form of a checklist questionnaire and then make revisions and complete the components or parts if there are incomplete. Based on the self-evaluation results conducted by filling out the self-evaluation questionnaire, the components, or parts of the coursebook to support the Merdeka curriculum on green chemistry material developed are complete, so no revisions are needed to prototype I.

Prototype III

After completing an expert assessment and a one-on-one examination of prototype II, prototype III was created. Two chemistry teachers from SMAN 8 Padang and three chemistry lecturers from FMIPA UNP were involved in the expert evaluation stage. In this case, the experts acted as validators who assessed prototype II through an evaluation questionnaire given in the form of a content validity questionnaire. The expert review aims to determine the level of validity related to content, presentation, language, and graphics. After the data is processed, the results of the content validity analysis can be seen in Figure 3.



Validators 1, 2, and 3 stated that the textbooks were suitable for use with minor revisions, while validators 4 and 5 stated that the textbooks were suitable for use without revision. Some suggestions given by validators that can be used as guidelines in revising prototype 2, are that it is better to add attractive image illustrations to make it more interesting, there is additional material so that the concept map and table of contents need to be revised, and the answer key needs to be elaborated again.

From the results of the validation that has been carried out, then revisions are made to the textbook as follows



Figure 9. Table of contents Figure 10. Concept maps Figure 11. Answer keys

After prototype II is evaluated by experts through the expert review stage, then a one-to-one evaluation will be carried out by conducting interviews with three phase E students of SMAN 8 Padang. This stage aims to find out how students respond to textbooks to support Merdeka curriculum learning on green chemistry materials developed. According to the outcomes of the stage of one-on-one evaluation, it is discovered that the overall appearance of the coursebook is attractive, the cover is very good, the material content is complete and detailed, there are various activities that are diverse and in accordance with the application of the Projek Pelajar Pancasila, exercise questions that also varied in accordance with the demands of the questions in the Merdeka curriculum and not only contains long written content but there are image models on each existing material writing so that it adds and makes it easier for students to understand the material and there are also various projects that can improve the abilities and creativity of students inside and outside the classroom.

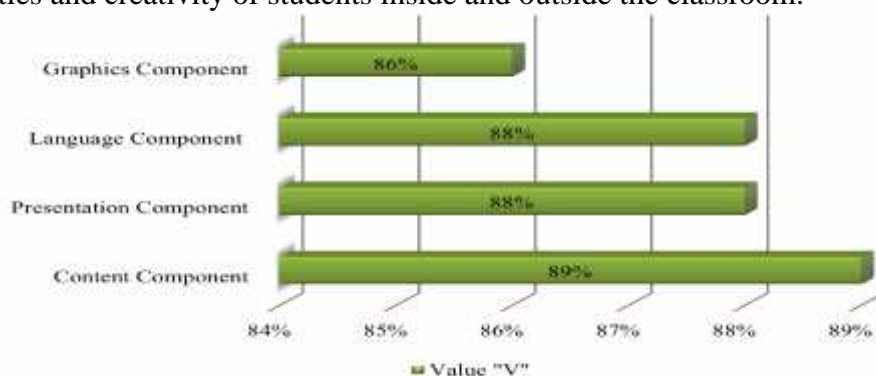


Figure 12. Diagram Showing the Results of Validity Analysis

Based on the validity scores given by five validators, each component in the developed textbook was valid, with an average validity value was 88%. It means that the coursebook to



support Merdeka curriculum learning on green chemistry material has met the criteria contained in the validity questionnaire to be applied in learning.

Prototype IV

After prototype III was produced, a small group test would be conducted. This small group test was conducted on three chemistry teachers of SMAN 8 Padang and nine students of phase E of SMAN 8 Padang with different ability levels of students who are high, medium, to low, which were made into three small groups to assess the developed product's level of practicality. After that, learning would begin using the developed textbook. Students would also be required to complete a questionnaire on practicality, the results of which will be employed for determining the level of practicality. After processing the data from the practicality questionnaire, a practicality level of 91% was obtained with a very practical category. The results of the practicality data analysis are in Figure 4.

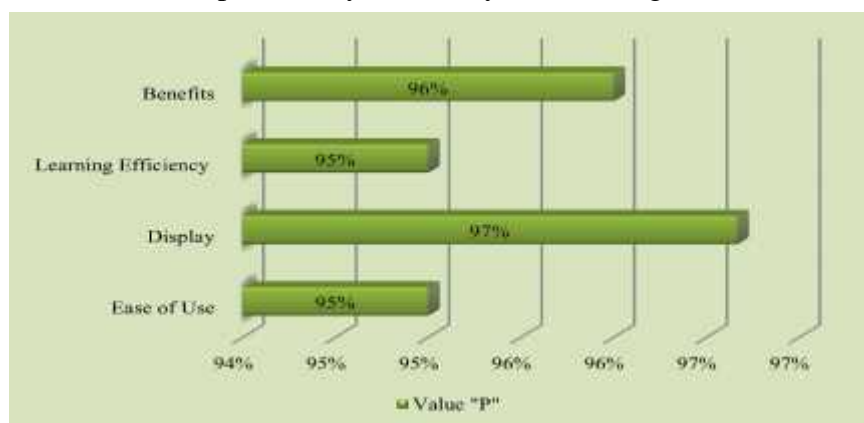


Figure 13. Diagram Showing the Results of Small Group Practicality Analysis

At this stage, data were also collected from two chemistry teachers by filling out a practicality questionnaire to determine the level of practicality. After the data was processed, the level of practicality was 96% with a very practical category. The results of the practicality data analysis can be seen in Figure 5.

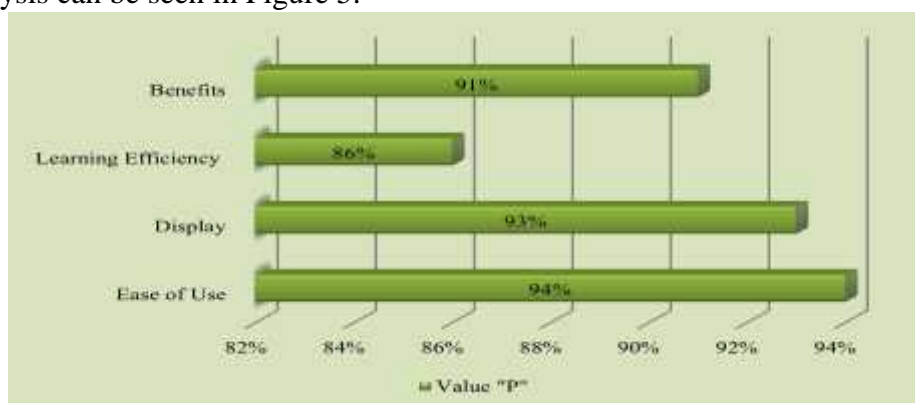


Figure 14. Diagram of Teacher Practicality Analysis Results

Based on the level of practicality of textbooks to support Merdeka curriculum learning on green chemistry material, it is included in the very practical category in terms of ease of use, time efficiency, and benefits. The results of the practicality data analysis showed that the designed prototype IV had good quality and was certainly valid and practical for use in the learning process.



Figure 15. Principles of green chemistry as one of the questions in the textbook

One of the key question models that students must answer can be seen in Figure 15. Here students are relied upon to know the various principles of green chemistry. From the results of interviews conducted with students, it is known that the principles of green chemistry consist of 12 principles, namely waste prevention, Prevention, Atom Economy, Less Hazardous Chemical Syntheses, Designing Safer Chemicals, Safer Solvents and Auxiliaries, Design for Energy Efficiency, Use of Renewable Feedstocks, Reduce Derivatives, Catalysis, Design for Degradation, Real-time analysis for Pollution Prevention and Inherently Safer Chemistry for Accident Prevention. At this point, students are relied upon to answer key questions accurately. Since these models are known to students who are taught using a variety of chemical representations, they consider each aspect of the meaning that every model conveys. Additionally, one of the elements that significantly impacted students' mental models in this study was the teacher's choice of instructional materials. Students are drawn to learning materials that provide multiple chemical representations, which helps them grasp the concepts. Students may struggle to understand concepts if no visual representations are available. This stage aims to determine how students respond to the book developed in learning. Based on the results of practicality test interviews conducted with students, it is found that the image display in the textbook was obvious and exciting and with present multi representations, making it easy for students to understand the material and the concepts given in the textbook and the language used was easy to understand, the instructions and questions given were very clear, making it easier for students to answer the questions given and grasp the concept more deeply. Hence, using textbooks is not an obstacle for students in carrying out learning and is practical to use in learning.

Conclusion

The results of this study conclude that the Plomp development model can be used to develop textbooks to support the Merdeka curriculum on green chemistry material phase E, textbooks to support an Merdeka curriculum on green chemistry material phase E that have been developed are categorized as valid with an average validity value was 88%, based on the results of the assessment of the small group trial, it can be seen that the textbooks to support the Merdeka curriculum on green chemistry material phase E that have been developed are categorized as very practical with an average value of practicality by students was 91% and practicality by teachers is 96%.

Recommendation

Following the results of this study, the following recommendations were made; For teachers, it is hoped that teachers can use it as an additional learning resource on green chemistry material and can support Merdeka curriculum learning and improve the abilities of teachers



and students in 21st-century learning; For students, it can help and facilitate students in understanding green chemistry material because students can learn according to their learning style abilities by being given various activities and activities that are also following the Proyek Pelajar Pancasila; For further researchers, it is hoped that they can conduct an effectiveness test on coursebooks to support Merdeka Merdeka learning on green chemistry material in phase E.

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