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DEVELOPMENT OF TEACHING MATERIALS FOR MAKING SIMPLE ENERGY-PRODUCING DEVICES IN RENEWABLE ENERGY TOPIC

Ilham Fauzi, Mawardi mawardi*, and Okta Suryani
Department of Chemistry Education, Faculty Of Mathematics And Natural Science, Universitas Negeri Padang, Padang, Indonesia
*Email: mawardianwar@fmipa.unp.ac.id

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Abstract: The change in curriculum to a Merdeka Curriculum causes changes in the learning system in Indonesia because this requires teachers and students to be more innovative and creative. To balance this requires teaching materials that can meet these needs, especially renewable energy materials; this material is new, so there are still few teaching materials available. The available renewable energy teaching materials are not carried out in practicum, so teachers still use references to the previous curriculum teaching materials, which are no longer significant. This type of research is educational development research or Educational Design Research (EDR). The stages of development research consist of 3 main stages: preliminary research, prototyping stage, and assessment phase. The development model used in this research is the Plomp development model developed by Tjreed Plomp. The research instruments used were interview sheets and questionnaires in the form of validity sheets which were analyzed with Aiken's V scale and practicality sheets. The validity test results were obtained by Aiken's V scale of 0.93 with high validity, which means that the developed teaching materials are valid. The practicality test results for the small group were 89% with very high practicality. Based on the teacher response questionnaire with very high practicality and obtained 93% based on the student response questionnaire with very high practicality, the teaching materials developed are practical. Based on the study's results, the teaching materials of the Independent Curriculum on renewable energy Phase E are valid and practical.

Keywords: *Teaching Materials, Renewable Energy, Merdeka Curriculum, Biogas Energy.*

INTRODUCTION

Indonesia's education system has undergone a significant change in the implementation process due to the impact of Covid-19, which causes aspects of life to change and requires rapid adjustment [1]. COVID-19 has ended, so the government has made several adaptations in the education sector, namely with the release of the Merdeka Curriculum. Merdeka Curriculum continues the development of the previous curriculum, which is holistic, competency-based, and designed according to the context of the needs of students [2]. Merdeka Curriculum demands creativity from teachers and students. In another sense, Merdeka's "Freedom" of learning is freedom of thought determined by The Teacher because the teacher is at the center of this new education system [3].

In this case, innovative and creative students and teachers must adapt quickly. Therefore, this is a concern, especially for the government of the Republic of Indonesia, to provide adequate infrastructure in the face of this global development. One of them is equipping learning resources such as teaching materials. The presence of teaching materials is very important to prepare students for the era of Revolution 4.0 and Civilization 5.0 [4]. This evolution is shown by the use of synchronized technology to create chances that advance education. Therefore, four competencies were added to the education curriculum: critical thinking ability, creativity and innovation, communication skills, and the ability to collaborate [5]. Students with a good interest in reading have high intelligence and 4C skills to win global competition in the 21st century. In fact, students' interest in reading is still low [6]. The commonly used source books are books with relatively long pages. Most of these books use few pictures and colors, so they have an unattractive appearance; these things cause the low reading interest of students[7].

In line with that, the problem that exists in some teaching materials is that there are still many that display illustrations or colorless images that make it difficult for students, so it is necessary to innovate teaching materials that are easy for readers to understand that display illustrations that attract students to learn more about a subject matter [8], especially in teaching materials on renewable energy material. This renewable energy material is a new material that has just appeared in this Merdeka Curriculum. In the teaching materials that researchers find renewable energy material that is already available, practicum activities have not been carried out because, learning with practicum, students get direct experience and can encourage scientific attitudes in students [9], besides that an attitude of curiosity, critical, open and cooperation will appear, This theory is supported in research [10], chemistry lessons will be effective if practicum activities support the explanation of the theory.

In the teaching materials that will be made, researchers discuss how to utilize renewable energy sources and make simple biogas-producing tools from using cow dung waste. The material made is in line with the Pancasila Student profile in part of creative, critical thinking, independence, and cooperation

because it is expected that students are responsible for the process and results of their learning, students can carry out joint activities willingly, students can reason critically, and finally, students can produce meaningful, helpful, and impactful. From the problems described above, one of the solutions that can be overcome is that researchers develop teaching materials to support an independent learning curriculum equipped with structured book systematics, more ordered and detailed material content, and more varied and colorful images.

RESEARCH METHODS

This type of research is educational development research (EDR). EDR is the systematic analysis, design, and evaluation of educational interventions with the dual purpose of producing research-based solutions to complex problems in educational practice and increasing knowledge about the characteristics of interventions and the process of designing and developing them [11-12].

The development model used in this study is the Plomp development model developed by Tjreed Plomp. In Plomp's development, the stages of development research consist of 3 main stages: preliminary research, prototyping stage, and assessment phase [12-13]. In this study, we developed teaching materials based on the Merdeka Curriculum on renewable energy material in the E phase. The description of activities at each stage of development can be broken down into the following stages.

Preliminary Research

In this stage, several activities are carried out: needs analysis, context analysis, literature study, and conceptual framework development. It needs analysis, and context analysis is required to develop the learning system. As well as other activities, namely conducting literature studies and developing conceptual frameworks.[12,14]. The framework will briefly explain the problems in the school and provide solutions to them. [15].

Prototyping Stage

At this stage, the previous stage's results, namely preliminary research, will be used as the basis for conducting formative evaluations in prototyping. In each prototype, formative evaluation is carried out to improve and refine the development design made to enhance and refine the development design made. This prototyping stage will be divided into four prototypes consisting of prototype I, prototype II, prototype III, and prototype IV. In the prototyping stage, there are four formative evaluation stages: self-evaluation, expert review, One-to-one evaluation, and small-group testing. Still, this research is limited to small-group testing.

1. Prototyping I

At this stage is designing teaching materials, such as design, compatibility with the independent curriculum, determining learning objectives, compiling material content, and making activity activities in teaching materials.

2. Prototyping II

After designing teaching materials in the prototype, I conducted a self-evaluation using a questionnaire on the teaching materials created, such as the completeness of essential components in teaching materials, word alignment, and other minor errors. [12, 16].

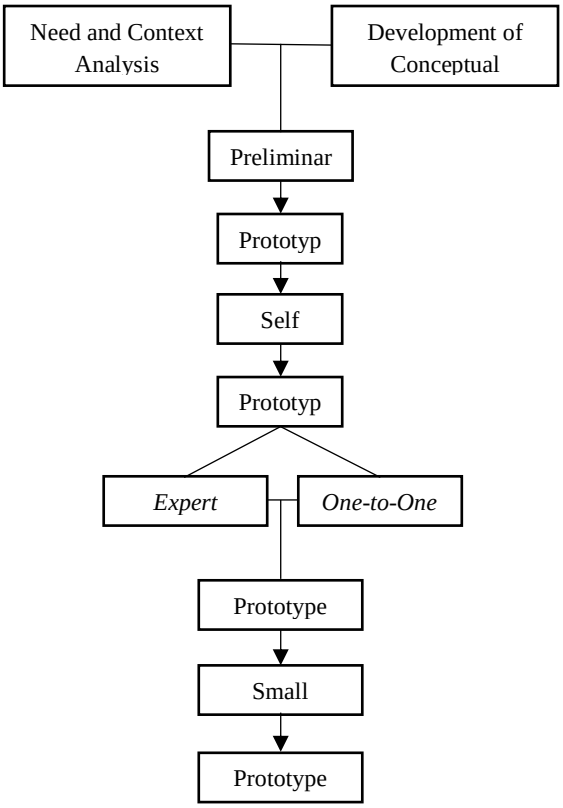

Figure 1. Framework for stages of teaching materials development to support Merdeka curriculum learning on renewable energi

3. Prototyping III

After making revisions during the self-evaluation, the next is to conduct an expert review; this review requires two chemistry lecturers and three chemistry teachers to assess teaching materials. According to [17], the expert review is carried out through the provision of an evaluation questionnaire which aims to determine the level of validity using Aiken's V scale. In addition to the expert review, in this prototype, a one-to-one evaluation was carried out by interviewing three phase E students; the purpose is to find out the students' responses to the teaching materials being developed.

4. Prototyping IV

at this stage, a small group trial is carried out by gathering nine students who have varying abilities, then dividing students into several groups and carrying out the learning process using these teaching materials; after that, students are asked to fill out a questionnaire and provide suggestions and criticism of the teaching materials that have been made.

Assessment Phase

The assessment phase is carried out by means of a field test. The field test aims to conclude whether the product can be used in practice in the field. However, this stage of the research was not carried out because the research was limited to the prototyping stage (Figure 1).

RESULTS AND DISCUSSION

Based on the research procedures that have been carried out, chemistry teaching materials are produced by making simple energy-producing devices within the scope of Renewable Energy material to support the Merdeka Curriculum. This research uses the Plomp development model, which consists of 3 stages. The following are the results obtained during the research process.

Preliminary Research

This preliminary research stage is carried out to identify and analyze the requirements needed in teaching material development research; at this stage, a needs analysis, curriculum analysis, student analysis, and concept analysis are carried out. The following are the results obtained from each stage of the initial investigation.

1. Need Analysis

At the needs analysis stage, interviews were conducted with three chemistry teachers from 3 different schools that have implemented the Merdeka Curriculum; why was it carried out in 3 other schools so that the resulting interview results were more varied, and why was it carried out only in schools that have implemented the Merdeka Curriculum because this research will develop chemistry teaching materials to support the Merdeka Curriculum. Interviews were conducted to discover the general problems that occur during the chemistry learning process, especially on renewable energy material, and how the Merdeka Curriculum is implemented in the school.

The problems with curriculum changes cause teachers to continue using old teaching materials because the available teaching materials still need to be coherent in their presentation. Therefore, a readable Merdeka Curriculum teaching material is required that can be understood by the teacher to maximize the teaching and learning process, especially in teaching materials for renewable energy materials.

2. Context Analysis

At this stage, you are identifying, detailing, and systematically compiling the scope of learning outcomes, materials, and strategies selected to develop teaching materials.

a. Literature Review

At this stage, researchers will conduct a literature study of several scientific journals related to the problems found and try to find solutions to the difficulties encountered in the field. The results obtained based on the literature study are 1. Teaching materials as a source of resources in achieving independent learning in class and the availability of quality and affordable teaching material facilities supported by high reading interest is a prerequisite for 21st-century life skills [18]. 2. The components of teaching materials used follow the reference teaching materials provided by the Ministry of Education and Culture. 3. It is known that the Plomp model developed by Tjeerd Plomp is one of the appropriate development models for this research.

b. Development of Conceptual Framework

At this stage, connecting problems or problem identification derived from needs analysis and context analysis with literature studies as a reference in developing teaching materials. Conceptual analysis is carried out by determining the main concepts that students will learn and systematically designed according to the following sequence:

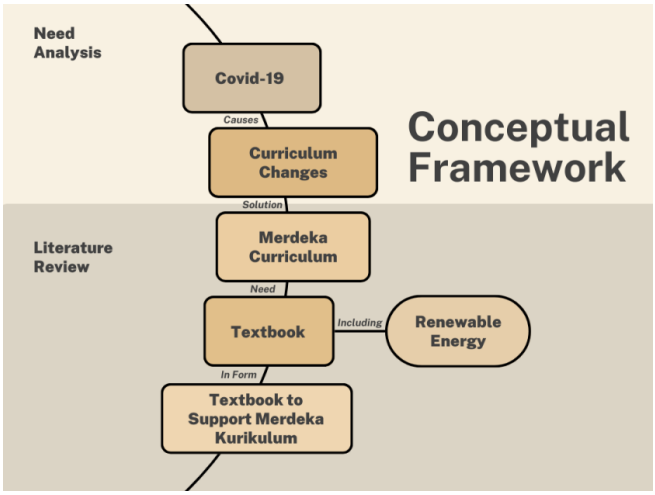

Figure 2. Conceptual framework

Prototyping Stages

1. Prototype I

Prototype I is a prototype resulting from the design and realization of the Preliminary Research stage. Prototype I supports the Merdeka Curriculum on renewable energy materials with complete, systematic, or coherent components and content. As an example of one of the results of prototype I, namely, there is a cover and several pages on teaching materials which can be seen in Figure 3.

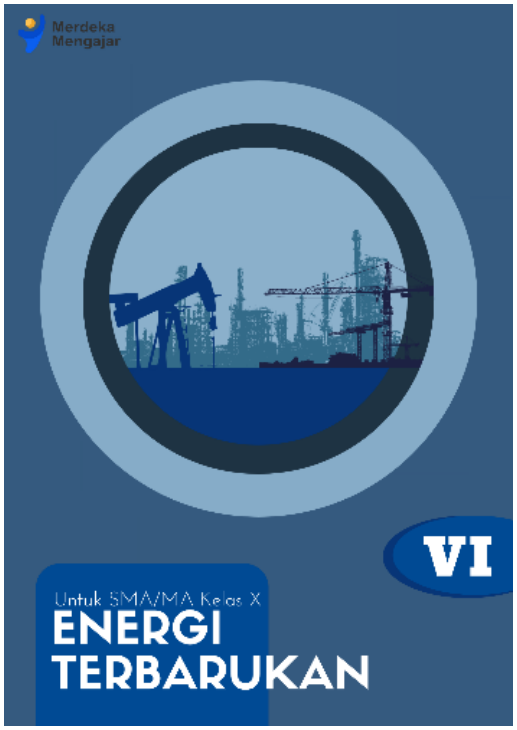

Figure 3. One of on teaching materials

2. Prototype II

The prototype results will then be formative evaluated by conducting a self-evaluation of the prototype I. At this stage of self-evaluation, researchers make corrections and review the completeness of the teaching material components to support Merdeka Curriculum learning with instruments in the form of questionnaires and then complete the incomplete components. Based on the results of the self-evaluation that has been carried out by filling out a self-evaluation questionnaire, the components of teaching materials supporting the Merdeka Curriculum on renewable energy material that have been developed are complete, so there is no need to revise prototype I.

3. Prototype III

Prototype III is a prototype resulting from revisions made to prototype II. After prototype III is formed, at this stage, formative evaluation is carried out in the form of expert review and one-to-one evaluation.

a. Expert Review

The expert assessment aims to get a scientifically valid prototype. The expert review involves two Chemistry lecturers from FMIPA UNP and three Chemistry teachers from Public High School 14 Padang. 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 assessment from these experts aims to determine the level of validity related to the content, presentation, discussion, and graphics. After the data is processed, the resulting content validity analysis data can be seen in the figure. The overall average is 0.93, which is included in the valid category. However, even though prototype II has shown very high validity, the validator gave some suggestions, which must be corrected.

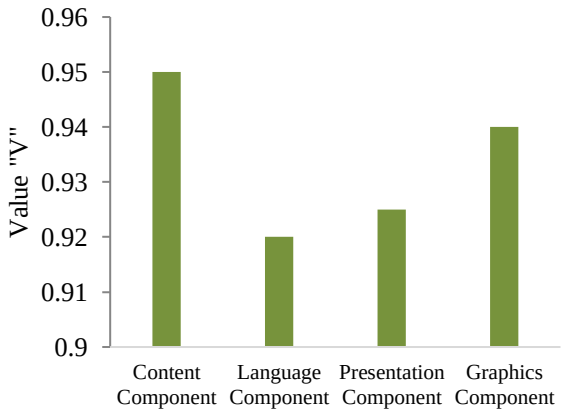

Figure 4. Diagram showing the results of validity analysis

b. One-to-One Evaluation

This test was conducted on 3 phase E students in Public High School 14 Padang who had studied renewable energy materials. This stage aims to determine how students respond to the teaching materials to be developed. Based on the results of interviews conducted at this stage, it was concluded that teaching materials that support the Merdeka Curriculum on renewable energy materials in terms of the appearance of teaching materials are interesting, presentation of the material is easy to understand, interest in learning and have no difficulty in understanding the teaching materials.

4. Prototype IV

Practicality results were obtained in small group evaluation to reveal practicality. This small group trial was conducted on 2 Public High School 14 Padang chemistry teachers who taught in Phase E and on 9 Phase E3 students at Public High School 14 Padang with different levels of student ability, namely high, medium-low, which were made into three small groups to determine the level of practicality of the product developed. This small group stage begins with learning about renewable energy materials; after learning, students are asked to carry out teaching materials, such as end-of-chapter exams, let's practice, and other activities in teaching materials. After carrying out the activities, students are asked to fill out a practicality questionnaire which will then be used to determine the level of practicality. After processing, a practicality level of 91% was obtained with a very practical category. The results of the practicality data analysis can be seen in Figure 5.

At the prototype IV stage, the practicality questionnaire is given to students, and two chemistry teachers fill out a practicality questionnaire sheet which helps know the level of practicality. After processing, the practicality value obtained was 93%,

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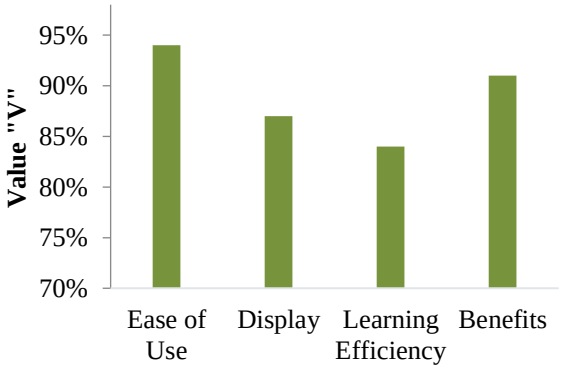

Figure 5. Diagram of student practicality, showing the result of small group analysis

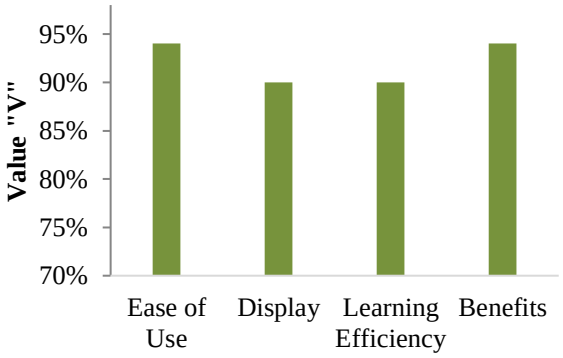

Figure 6. Diagram Showing teacher practicality analysis results

Based on the practicality of teaching materials that support the independent Merdeka Curriculum on renewable energy material, it is included in the very practical category in terms of ease of use, appearance, learning efficiency, and benefits of the teaching materials. The results of the practicality data analysis on prototype IV that has been designed have good quality and are certainly valid and practical for use in the learning process.

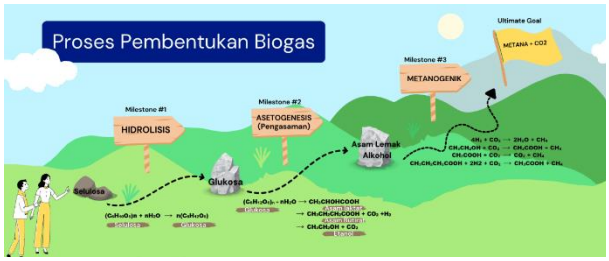

Figure 7. One of the picture activities that help students in answering questions

One of the activities in the teaching materials, which can be seen in Figure 7, based on the answers that students have made, it is known that the steps of making biogas are very clear from the hydrolysis stage, then to the acetogenesis stage, then to the last methanogenic stage and then biogas (methane) is produced. The pictures in the activity are beneficial in understanding the process of making biogas. The pictures are exciting and easy to read so students can answer the questions correctly. Combining interesting depictions can help students track ideas in the natural world. Without it, students will face misguided assessments, and with the help of depictions, learning is more significant [19].

Safe renewable energy learning development is ideally based on a practicum that illustrates the implementation of renewable energy in daily life [20]. From this reference, researchers load practicum sheets in teaching materials, which makes this teaching material unique, because the practicum available in this teaching material utilizes cow dung to produce biogas. From this practicum, students can illustrate the implementation of renewable energy in daily life.

CONCLUSION

Based on the results of research and development of chemistry teaching materials to support the Merdeka Curriculum on renewable energy materials, it can be concluded that chemistry teaching materials on renewable energy materials can be developed with the Plomp development model consisting of preliminary research, prototyping phase, and research phase (assessment phase). Chemistry teaching materials on renewable energy Phase E materials produced have very high validity at 0.93, and practicality in teachers is very practical at 95% and practicality in students at 91%.

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