



## **Creation Alternative Energy Electronic Student Worksheets (E-LKPD) Based on the "Nabuang Sarok" Waste Management Program to Improve Students Environmental Concern**

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### **ABSTRACT**

*Through the use of online graphic design platform CANVA and waste management programs, this study seeks to create electronic student worksheets to enhance students environmental awareness using Model Problem Based Learning on alternative energy. The ASSURE model, which includes the development stage, is applied uses the Research and Development methodology. At SMA Negeri 8 Padang, observations the school environment and needs analysis involving 1 physics teacher and 28 students were conducted as part of the analysis stage. Based on these initial observations, it was found that students' environmental awareness was still low. In addition, students understanding of alternative energy was quite limited because digital teaching materials had not been fully utilized. Based on these identified problems, digital student worksheets on waste management programs were created to boost environmental awareness using the Model PBL. By using the Kappa Moment, the product feasibility validity test conducted by three physics lecturers confirmed the content, language, presentation, and graphics were valid. Revisions were made based on their feedback. Based on results, it was shown the electronic student worksheet on alternative energy based on the waste management program "Nabuang Sarok" is appropriate to use, especially in the independent curriculum, to improve students' environmental awareness.*

**Keywords:** E-LKPD, Alternative Energy, Problem Based Learning, Nabuang Sarok, Enviromental Concern.



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## **I. INTRODUCTION**

The Industrial Revolution 4.0, or 21st-century education, has been ushered in for Indonesian education. As science and technology get more advanced, this age is changing along with them. A paradigm shift in learning is being driven by 21st-century education, which includes changes in the curriculum, media, and technology employed [1]. Every person can grow his or her knowledge, abilities, and attitudes as well as all of his or her potential through education [2]. In addition to emphasizing knowledge, learning in this century also aims to cultivate skills [3]. The four Cs of this century are creativity, teamwork, communication, and critical thinking and problem solving [4,5].

According to the Minister of Environment and Forestry Regulation Number 14 of 2021, waste banks manage waste based on the 3R principles: reduce, reuse, and recycle. They are created by communities, businesses, and local governments to promote better waste management and support a circular economy. Waste banks must meet requirements for management, facilities, and governance, and their success relies on integrating various aspects like institutional, financial, regulatory, community participation, and operational factors. Research in Padang City shows plastic waste increased significantly from 2009 to 2019, with the largest types being PP and PET used in packaging. This rise is linked to population growth and lack of understanding about waste sorting. Additionally, waste disposal facilities are inadequate, leading many to improperly dispose of plastic waste into rivers [6,7].

PT Semen Padang has taken steps to reduce coal usage in production by creating alternative fuels from waste, such as rice husks, Spent Bleaching Earth (SBE), sawdust, discarded cement bags, and palm fruit fibers. All these materials have been tested and meet calorific value and proximate analysis standards. Additionally,

they utilize sorted waste to produce Refused Derived Fuel (RDF) through the Nabuang Sarok program, which is a waste management system. This program started on July 5, 2022, and is website-based, aiming to reduce the quantity of waste. The accepted waste includes plastic, wood, paper, leaves, dry twigs, and used cooking oil. Customers can exchange points earned from deposits for rewards. As of December 2023, there were 1,466 customers who deposited a total of 131,652.62 kg of solid waste and 2,283.11 liters of used cooking oil. Deposits are made every Tuesday and Thursday at the PT Semen Padang Multipurpose Building, where the waste is weighed and sorted in system [8].

In addition, based on direct observation at one of the high schools in Padang, namely SMA Negeri 8 Padang, it was found that students have not shown an attitude of environmental care, even with small actions such as throwing trash in the available bins and reducing plastic use. Another factor supporting the students' lack of environmental care attitude is the small scope that students are indifferent to the condition within the classroom. This is evident from desk drawers still containing trash, classroom cupboards—which are school facilities—not being used to store class equipment but for storing helmets and unused second-hand books, indifference when the classroom is dirty, and a lack of concern for sorting trash by type even though categorized bins are available outside. Based on this issue, the solution suggested by the researcher is to create electronic student worksheets containing material on alternative energy related to the environment, particularly regarding waste. By incorporating the "Nabuang Sarok" waste management program, it is expected to be able to improve students' attitudes toward the environment by fostering a caring awareness.

## II. METHOD

The procedure in this research uses the ASSURE model. The role of the ASSURE model is as a reference to help teachers plan, identify, state objectives, select models and materials, and assess appropriately. The ASSURE model consists of 6 stages: "Analyze Learners; State Objectives; Select Strategy, Technology, Media, and Materials; Utilize Technology, Media, and Materials; Require Learner Participation; and Evaluated and Revise". However, this research is limited to five stages, skipping the Require Learner Participation stage, which includes validity testing by experts

**Table 1.** Model ASSURE Procedures

| Stage of the ASSURE Learning Design Model | Description                                                                                                                                                                                                       |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Analyze Learners                          | It began with observing the students and their environment, followed by analyzing the results of the questionnaires that had been given to the students.                                                          |
| State Objectives                          | In the Merdeka Curriculum, Learning Objectives are formulated with reference to Learning Outcomes.                                                                                                                |
| Select Methods, Media and Materials       | The method used involves an approach to the environment, particularly regarding waste issues, with the media used being E-LKPD created using the Canva application and the access tool in the form of a flipbook. |
| Utilize Media and Materials               | Using flipbook learning media that contains explanations of Electronic Student Worksheets.                                                                                                                        |
| Require Learners Participation            | This stage cannot be carried out because the research only goes up to the validity test.                                                                                                                          |
| Evaluate and Revise                       | The final stage is the stage of implementing improvements and reviewing the feasibility of the product.                                                                                                           |

The final step in the creation is the validity testing by three experts using a questionnaire to evaluate the feasibility and suitability of the electronic student worksheet integrated with the waste management program, with further improvements based on the feedback provided by the three experts. The subjects of this research are three expert validators, who are Physics lecturers from Universitas Negeri Padang. The instrument used is a validity questionnaire sheet containing 4 assessment components consisting of 23 indicators, namely: 1) Content

Feasibility, 2) Language of the E-LKPD, 3) Presentation, and 4) Graphics. The formula used to analyze the validation results of this electronic student worksheet product is Moment Kappa. Kappa moments are more commonly used in validation because of their ability to measure the level of agreement more accurately compared to simple percent agreement methods. Kappa takes into account the possibility of agreement occurring by chance or randomly, thereby providing a stronger indication of the reliability of an assessment. More specifically, Kappa moments correct for chance agreement, measure inter-rater reliability, are suitable for categorical data, involve more than just accuracy, and allow for standard comparisons.

The expert validation questionnaire aims to determine the feasibility of the electronic student worksheet based on the waste management program before its subsequent testing on students in schools by the next researcher. Validity testing uses a validation questionnaire instrument with a Likert Scale. The instrument used was a validation questionnaire sheet containing 4 assessment components and 23 indicators, namely: 1) Content Feasibility; 2) Language of the E-LKPD; 3) Presentation; and 4) Graphics. The formula used to analyze the validation results of this E-LKPD product is the Kappa Moment. The electronic student worksheet based on the waste management program is considered valid for use if it achieves a high validity percentage. The results of the validity test questionnaire assessment are based on the following Likert Scale:

**Table 2.** Likert Scale

| Gradation Scale | Score |
|-----------------|-------|
| Very Poor       | 1     |
| Poor            | 2     |
| Fair / Moderate | 3     |
| Good            | 4     |
| Very Good       | 5     |

The obtained data will be analyzed using the Moment Kappa formula with the following equation:

$$K = \frac{\rho_0 - \rho_e}{1 - \rho_e}$$

Information:

K = Kappa Moment Index

$\rho_0$  = Realized Proportion

$$\rho_0 = \frac{\text{Realized Value}}{\text{Total Value}}$$

$\rho_e$  = Unrealized Proportion

$$\rho_e = \frac{\text{Unrealized Value}}{\text{Total Value}}$$

The criteria for whether the created E-LKPD product is valid or not are determined based on the Moment Kappa criteria as in the following table:

**Table 3.** Validity Category Interval

| Interval (%) | Criteria              |
|--------------|-----------------------|
| 0,81 – 1,00  | Substantial Agreement |
| 0,61 – 0,80  | Moderate Agreement    |
| 0,41 – 0,60  | Fair Agreement        |
| 0,21-0,40    | Slight Agreement      |
| 0,01 – 0,20  | Poor Agreement        |
| <0,00        | Not Valid             |

(Source: Ref [20])

### III. RESULTS AND DISCUSSION

#### Result

The results of this research are in three parts: 1) the display of the product, which is the electronic student worksheet on Alternative Energy Based on the "Nabuang Sarok" Waste Management Program to Enhance Students' Environmental Care Attitude, and 2) the value of the E-LKPD product validation that has been prepared. The main topic of this electronic student worksheet is Alternative Energy. The validation process for the E-LKPD product was carried out by three expert lecturers from the Physics Department, FMIPA UNP. The data collection instrument used was a questionnaire sheet. In the validation questionnaire, there are four main assessment aspects, namely: (1) Content Feasibility, (2) Language, (3) Presentation, and (4) Graphics. In the initial stage, the electronic student worksheet development was designed using the Problem Based Learning approach. The components presented in the E-LKPD include: (1) LKPD Identity, which covers the title, subject, semester, main topic, compiler, school, student name, and time allocation, (2) Learning outcomes and objectives, (3) LKPD usage instructions, (4) Problem orientation accompanied by supporting information, (5) Practice questions, (6) Assignment and reinforcement activities, and (7) Assessment. The elements integrated into the E-LKPD consist of text, visual illustrations, and video media. The video in the electronic student worksheet is the result of integrating the electronic student worksheet with YouTube. The appearance of the electronic student worksheet product is as follows:



Fig 1. Appearance Product.

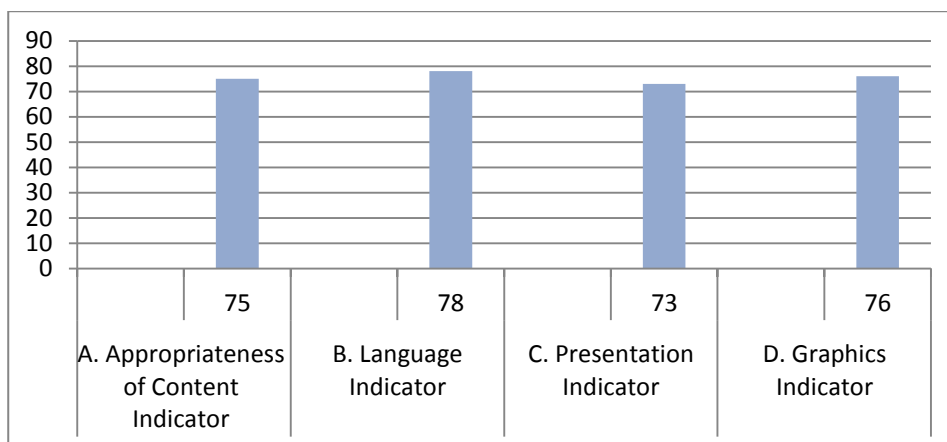
Based on validation questionnaire conducted by the lecturers on the electronic student worksheet, the following results were obtained:

Table 4. Average Validator Score

| No. | Assesment Indicators                                      | Value |
|-----|-----------------------------------------------------------|-------|
| 1.  | Content Feasibility Indicator covers 9 assessment aspects | 0.75  |
| 2.  | Language Component Indicator contains 4 assessment        | 0.85  |
| 3.  | Presentation Component Indicator includes 5 assessment    | 0.75  |
| 4.  | Graphics Indicator of 5 assesment                         | 0.77  |

In the overall context, the average validation value of the E-LKPD reaches 0.78 and is categorized as moderate. Details of the average validity values per indicator are visualized through the following graph. The suggestion from the first validator is that the content of the LKPD on alternative energy based on waste management programs is not very clear (only partly, especially on biomass), and the process of turning biomass into an alternative energy source is not depicted/explained (only the advantages are mentioned). In the section of the questions used, no main title has been made above the questions, and it does not yet guide students to develop critical thinking on alternative energy material during the waste management section. The suggestion from the second validator is that fundamental questions are not necessary, supporting information should be placed before the activity, and problem-solving questions should be adjusted according to TP and IKTP. The

suggestion from the third validator, regarding Biomass Energy material, especially in the fundamental question section at number 3 (guiding investigation), is that there should be an explanation provided to students to conduct observations, include videos/animations supporting the material, and create comparison questions present in the section on the utilization of energy alternative.



**Graphic 1.** Validation Results E-LKPD Product by Expert Lecturers

Based on the graph above, it can be seen that the E-LKPD that has been created has a valid feasibility level as seen from various validity assessment indicators. This indicates that this E-LKPD is feasible as physics teaching material to improve students' environmental awareness, especially on the Alternative Energy material in Phase E of Senior High School.

## Discussion

The product of this research is electronic student worksheet on alternative energy based on the "Nabuang Sarok" waste management program to enhance students environmental care awareness. The material in this learning media is about Alternative Energy. This electronic student worksheet was created using the Canva application, then converted into a flipbook format. The creation of the E-LKPD was carried out by following the stages suggested by Prastowo. This learning media product is compiled through the implementation of the steps of the Problem Based Learning Model. The implementation of the PBL Model learning is able to increase students capacity for problem-solving.

The stages of the Problem Based Learning Model used in this E-LKPD follow the opinion given by Trianto, namely: 1) Orienting students to the problem; 2) Organizing students for learning; 3) Guiding individual and group investigation; 4) Developing and presenting the work; and 5) Analyzing and evaluating the problem-solving process. To increase students' ability in physics problem-solving, this E-LKPD contains problem-solving indicators as proposed by Polya, namely 1) Understand the problem; 2) Devise a plan; 3) Carry out the plan; 4) Look back at the completed solution". These problem-solving indicators are applied in the learning evaluation questions. Meanwhile, the syntax of the PBL Model is applied to the stages of the learning process.

The implementation of the PBL Model in the electronic student worksheet shows integration with problem-solving ability indicators. This integration includes: 1) the problem orientation stage, which functions to direct students in identifying and understanding the problems faced; 2) the organization and learning assistance process to support students in planning and carrying out learning activities; 3) development and presentation of learning outcomes, which encourages students to express their learning process and achievements through work in the form of videos, reports, or other relevant products; and 4) analysis and evaluation of learning activities, which provides an opportunity for the teacher to assess the achievement of learning outcomes as well as the success of the problem-solving strategy carried out by the students. With the alignment between the characteristics of PBL and the function of the learning media, the utilization of this tool in physics learning has the potential to increase students' capacity in mastering physics problem-solving skills.

To test the feasibility level of electronic student worksheet product, a validation questionnaire sheet was used to obtain assessment data. This evaluation was carried out by three lecturer validators from the UNP Physics department: 1) Prof. Dr. Festiyed, M.S.; 2) Dr. Hamdi, M.Si.; and 3) Selma Riyasni, M.Pd. The product validation questionnaire sheet contained 23 questions divided into 4 evaluation components, including: 1) Content Feasibility; 2) Language; 3) Presentation; and 4) Graphics. In general, the validation results show that the electronic student worksheet received a range score of 0.78, which is in the moderate category. This finding

indicates that the developed E-LKPD has a moderate feasibility level, so it can be considered a suitable tool to be utilized in the physics learning process on the Alternative Energy topic in Phase E of the SMA level.

Before being considered valid, the E-LKPD on Alternative Energy Based on the Waste Management Program underwent a number of changes and improvements based on comments and suggestions from the Validator lecturers. Referring to the validation questionnaire and the directions from the validator lecturers, several improvements have been made to the E-LKPD, including deepening the explanation of biomass and waste management, the process of waste into biomass as an alternative energy source, creating major titles on every activity page, placing supporting information before the activities, creating problem-solving questions according to TP & IKTP (Learning Objectives and Achievement Indicators), creating questions that guide students to conduct investigations in observation, embedding video links in the E-LKPD, and creating questions that involve calculations using formula equations. After making improvements to the content of the E-LKPD, the re-validation stage was carried out to the lecturers. Thus, this E-LKPD product is considered valid and can proceed to the next stages.

In the Content Feasibility component, there are 9 assessment sections. The average validation result obtained on the Content Feasibility indicator is 0.75, which falls into the valid category. This component contains material referring to the Merdeka Curriculum, E-LKPD according to CP&TP, correctness of the material substance, and the presentation of E-LKPD in accordance with the PBL Model syntax. The Language component has 4 questions with an average validation score of 0.85, which is classified as very high. Indicators in this component include that the font type and size in E-LKPD are easy to read, the information in E-LKPD is clear, proper Indonesian rules are used, and the language is concise and clear. The Presentation component has 5 questions with an average validation score of 0.75, which falls into the moderate category. Indicators in this component include clear indicators and learning, sequential order, Problem-Based Learning-based, containing main points and supporting information, and illustrations relevant to the supporting information. The last component is Graphics, consisting of 5 items with a validation score range of 0.77, which falls into the moderate category. The evaluation indicators include attractive font shape and size, a cover design that reflects alternative energy material, color choices in the E-LKPD that maintain harmony with the text and do not distract from students' learning focus, and the placement of appealing illustrations.

Before being considered valid, this E-LKPD product on Alternative Energy Based on Waste Management Program underwent several changes and improvements based on comments and suggestions from the Validator lecturer. Referring to the validation questionnaire as well as guidance from the validator lecturer, several improvements have been made to the E-LKPD, including deepening explanations about biomass and waste management, the process of turning waste into biomass as an alternative energy, creating a main title on each activity page, placing supporting information before the activity, creating problem-solving questions according to TP & IKTP, making questions that guide and assist students in conducting investigations during observations, including video links in the E-LKPD, and creating questions that involve calculations using formula equations. After the improvements to the E-LKPD content were carried out, the re-validation phase by the lecturer was then conducted. Thus, this E-LKPD product is considered valid and can proceed to the next stage.

#### IV. CONCLUSION

This development resulted in a student worksheet on alternative energy based on waste management. The assessment was validated by three validators. The results of the assessment validation test were categorized as valid. This shows that this learning medium is suitable for improving students' environmental awareness. The creation of these student worksheets is expected to be one solution to the problem of low student awareness. Teachers can use this digital learning medium to motivate students to increase their interest in learning. Schools are expected to support teachers in increasing their use of digital teaching materials in line with the latest developments in technology. Schools must also provide the necessary facilities and infrastructure to foster environmental awareness and take firm action against students who remain indifferent. Future researchers should continue this study by implementing the required learner participation stage directly in schools.

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