

VALIDITY OF DEVELOPING PjBL-STEM BASED WORKSHEET ON THE TOPIC OF ENVIRONMENTAL CHANGE AND PRESERVATION FOR STUDENTS AT MAN 2 PADANG PANJANG

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Abstract

The implementation of the Kurikulum Merdeka requires updated teaching materials that can accommodate suitable learning characteristics. This study is a development research using the 4-D model in three stages: define, design, and develop. The subjects of this study are 35 students from grade X of MAN 2 Padang Panjang, 1 biology subject teacher of MAN 2 Padang Panjang, and two lecturers from the Department of Biology, FMIPA UNP. The object of this research is the PjBL-STEM-based worksheet on environmental change and preservation material. Data for this study are obtained from teacher interviews, student observation questionnaires, and validity questionnaires. The result obtained for the product validity score is 91%, categorized as highly valid, thus can be used in biology learning.

Keywords : *Worksheet; PjBL; STEM; 4-D*

INTRODUCTION

In line with the implementation of Kurikulum Merdeka for educational units based on the Decree of the Ministry of Education, Culture, Research, and Technology number 56 of 2022, it is explained that the Kurikulum Merdeka is a flexible curriculum with an emphasis on essential materials but does not neglect the development of students' competencies and character (SMP, 2022). In its implementation, the Kurikulum Merdeka focuses on student-centered learning (Munawar, 2022). The Kurikulum Merdeka embraces the concept of education that is capable of providing literacy, knowledge, attitudes, skills, and proficiency in the use of technology (Ariga, 2023). Sultan Al Fasya et al., (2022) argue that the Kurikulum Merdeka emerges as a response to the educational challenges in the era

of the 4.0 revolution, which demands several skills from students. These skills include collaboration, critical thinking, communication skills, problem-solving skills, and creative thinking.

Through direct observation and observations conducted at MAN 2 Padang Panjang, it was found that starting from the academic year 2023/2024, MAN 2 Padang Panjang began implementing the Kurikulum Merdeka. The models commonly used in Biology learning are discovery learning, problem-based learning, and project-based learning. In Biology teaching, teachers generally use student worksheets as teaching materials. However, based on the observations conducted by the researchers, the student activity sheets used in teaching are not yet suitable for the needs of the Kurikulum Merdeka. Constraints found in teaching include students' misconceptions about the material being taught and a lack of motivation among students to participate in learning. The use of technology in teaching is also relatively low and does not yet reflect the characteristics of learning in the Kurikulum Merdeka.

Based on a questionnaire distributed to 35 students, it was found that students are still relatively passive in their learning. This is evidenced by 94% of students relying on the method of listening to teacher lectures in learning Biology. Meanwhile, for active learning methods such as gathering information from other sources, only 20% of students do so, 14% create concept maps, and 3% make small notes.

One of the topics considered difficult by students in the subject of Biology is the topic of environmental change and preservation. This is because students perceive this topic as heavily reliant on memorization, containing many Latin terms, and dense with theory. Regarding this difficult topic, the researchers attempted to provide test questions to assess students' environmental literacy abilities. From the results, the researchers found that in terms of knowledge, students scored relatively high, but in terms of attitude, behavior, sensitivity, and attention, students still scored relatively low.

To adapt to these changes, teachers as the primary actors in education play a role in selecting appropriate learning conditions. Learning conditions can be determined by choosing the right models, methods, approaches, and learning strategies. As supporters, teachers also play a part in utilizing appropriate teaching materials and learning resources.

The PjBL-STEM model is a combination of project-based learning with the fields of science, technology, engineering, and mathematics (Meita et al., 2018). The PjBL-STEM

model supports student-centered learning (Putri et al., 2021). By using the PjBL-STEM model, it will support the utilization of technology in learning (Afriana et al., 2016). The use of the PjBL-STEM model in learning is capable of meeting the demands of the 4.0 revolution era (Grahito Wicaksono, 2020).

According to (Han et al., 2015) when the PjBL-STEM model is used in teaching, it will help students to be creative in line with the growth of students' critical thinking abilities. Students taught using the PjBL-STEM model will have curiosity, adventure, and challenges, significantly fostering students' creativity (Lou et al., 2017).

To ensure the optimal implementation of the PjBL-STEM model, teaching materials that can accommodate all learning needs are required. In line with its goal of making students more active in learning, student worksheets are considered suitable choices as teaching materials (Febia et al., 2022). Student worksheets can be developed in such a way as to accommodate the needs of teaching the PjBL-STEM model to students. According to (Ma'sumah & Mitarlis, 2021) student worksheets can be combined with various teaching models to produce effective learning activities, such as project-based learning.

Based on the above description, the researcher is interested in conducting research on the development of student worksheets based on the PjBL-STEM model on the topic of environmental change and preservation at MAN 2 Padang Panjang.

METHODS

This study is a development research (R&D). The final result of this research is a product that goes through a series of development stages. All stages of this research follow the 4-D (Four-D Models) development model. 4-D (Four-D Models) was introduced by Thiagarajan at 1974. In the 4-D (Four-D Models), there are several stages that must be passed by researchers, including define, design, develop, and disseminate. However, due to time and funding constraints, the researcher limited the study to only three stages.

The research was conducted in two places, namely at MAN 2 Padang Panjang and the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. The research subjects were 35 students of class X at MAN 2 Padang Panjang and 1 Biology teacher at MAN 2 Padang Panjang. Meanwhile, the validators in this

study were 2 lecturers from the Department of Biology, Faculty of Mathematics and Natural Sciences, and 1 Biology teacher from MAN 2 Padang Panjang. The object of this research is student worksheets based on PjBL-STEM on the topic of environmental change and preservation for class X / Phase E of SMA/MA.

The research took place for six months from October 2023 to April 2024. The defining phase occurred in October 2023, while the design phase took place from November 2023 to January 2024, and the development phase was conducted from January 2024 to April 2024..

Data for this research is sourced from student observations, interviews with Biology teachers and validity tests. The validity questionnaire aims to determine the validity of the developed product. The preparation of the questionnaire refers to the format developed by the Ministry of National Education (Hernawan et al., 2008)

Preparation of validity questionnaires is organized based on the Likert scale with criteria:

Strongly Agree (SA)	: 4 point
Agree (A)	: 3 point
Disagree (D)	: 2 point
Strongly Disagree (SD)	: 1 point

1. Define Stage

In this stage, the researcher defines the requirements needed in developing student worksheets. Starting from analyzing the objectives, student analysis, concept analysis, task analysis, and analysis of learning objectives.

2. Design Stage

In this stage, the researcher creates an initial design of the student worksheets to be developed. The researcher conducts test preparation, media selection, format selection, and begins to design the initial layout of the student worksheets to be developed.

3. Develop Stage

In this stage, the researcher improves the initial design that has been prepared. If the prepared design is still not suitable, revisions are made. Then, expert validation is conducted using a validity questionnaire. Subsequently, if the product is declared valid.

Validity testing is conducted to determine the validity value of the developed product. The aspects assessed in this test include alignment with the curriculum, language, presentation, appearance, and PjBL-STEM model. The steps carried out in the validity test of student worksheets by the validators are:

- 1) Requesting the willingness of validators to conduct validity assessment.
- 2) Requesting validators to fill out the validation assessment using the provided questionnaire.
- 3) Based on the assessment results provided by validators, the researcher revises the developed student worksheets.
- 4) The researcher revises according to the assessment and suggestions provided by validators.

The research data obtained is then analyzed qualitatively and quantitatively. For the defining and designing stages, they are analyzed qualitatively and presented descriptively. Data from the development stage in the form of validity are analyzed quantitatively.

1) Analysis of PjBL-STEM Based Student worksheet Validity

The purpose of validity testing analysis is to measure the validity level of student worksheets as described below statements along with their values are assessed using the Likert scale with criteria:

Strongly Agree (SA) : 4

Agree (A) : 3

Disagree (D) : 2

Strongly Disagree (SD): 1

2) Determination of the highest score

Determination of the highest score using the following formula:

$$\text{Highest Score} = \text{Number of Indicators} \times \text{Number of Validators} \\ \times \text{Maximum Score}$$

3) Determination of validity value using the following formula

Determination of the validity score using the following formula:

$$\text{Validity Score} = \frac{\text{Total Score Obtained}}{\text{Highest Score}}$$

- 4) Determination of validity value categories based on modified criteria from Riduwan as follows:

Very Valid	: 81 – 100%
Valid	: 61 – 80%
Sufficiently Valid	: 41 – 60%
Less Valid	: 21 – 40%
Not Valid	: 0 – 20%
- 5) Student worksheets will be considered valid if their score reaches 61%, and if their validity test score is below 61%, revisions and reassessment are required until they meet the criteria of valid student activity.

RESULTS

The results of this research, based on the three stages of the 4-D approach (define, design, and develop) are outlined as follows:

1. Define Stage

The results of this analysis were obtained from direct observations, interviews, and questionnaire distribution to teachers and students at MAN 2 Padang Panjang. The definition stage consists of five steps with the following results:

a. Front-End Analysis

Based on observations and interviews conducted by the researcher, it was found that Biology learning at MAN 2 Padang Panjang uses student worksheets. Dense material explanations are packaged in student worksheets with information sources from printed books. The substance of assignments in the student worksheets focuses on cognitive abilities by summarizing material from printed books. In the learning process, there is no evidence of technology empowerment and honing of 21st-century skills, which are characteristics of Kurikulum Merdeka learning. The teaching materials used are considered not accommodating the learning demands that students must face according to the implementation of the Kurikulum Merdeka.

b. Learner Analysis

Based on learner analysis, it was found that students are still passive in Biology learning. Materials on environmental change and preservation are

considered difficult for students to learn. This is because the learning process is monotonous due to the lack of variety in learning media. Dense theoretical learning is also a hindrance to mastering the materials on environmental change and preservation.

c. Task Analysis

Task analysis is carried out to examine Learning Objectives and Learning Outcomes in the Kurikulum Merdeka. Task analysis serves as the basis for designing the flow of Learning Objectives that will be studied by students, especially in the material of environmental change and conservation. This activity aims to facilitate the determination of content and limit the material presented in student worksheets based on PjBL-STEM on environmental change and conservation in high school. In accordance with Biology Learning Outcomes in phase E which state that by the end of phase E, students have the ability to be responsive to global issues and actively participate in providing solutions. These abilities include observing, questioning, and predicting, planning and conducting research, processing and analyzing data and information, evaluating and reflecting, and communicating in the form of simple projects or visual simulations using available technology applications related to alternative energy, global warming, environmental pollution, nanotechnology, biotechnology, chemistry in everyday life, waste utilization, and natural resources, pandemics caused by viral infections. All these efforts are directed towards achieving sustainable development goals (SDGs). Through process skills, scientific attitudes, and the Pancasila learner profile are also built.

d. Concept Analysis

Based on the learning outcomes of Biology phase E, there are several topics studied by students in Biology learning during Phase E. One of them is the material on environmental change and preservation, which is considered difficult for students to learn.

e. Specifying Instructional Objectives

Based on these instructional objectives, the sequence of learning objectives is outlined as follows:

- 1) Students are able to analyze presented problems and provide assessments in accordance with their knowledge and experience.

- 2) Students can comprehend the concept of environmental balance and change through guided literature study.
- 3) Students are capable of analyzing the cause-and-effect of issues and designing ideal settlements for sustainability through guided literature study.
- 4) Students can develop design and implementation skills using the craftsman game.

2. Design Phase

The design phase is conducted in accordance with the development steps outlined by the Ministry of Education (Hernawan et al., 2008). Worksheets are developed using the Canva application. Components within the worksheets include cover, student identity, preface, table of contents, worksheet profile, STEM introduction, worksheet usage instructions, competency mapping, learning activities following the PjBL-STEM syntax, assessment, and bibliography.



Image 1 Cover of the Worksheet Display

3. Development Phase

Validation of the PjBL-STEM-based worksheets (LKPD) is conducted by two lecturers from the Department of Biology, Faculty of Mathematics and Natural Sciences, and one biology subject teacher from MAN 2 Padang Panjang. A

summary of the validation analysis of the PjBL-STEM-based worksheets can be seen in the following table:

Table 1. Table of Validation Results for PjBL-STEM-based Worksheets on Environmental Change and Preservation Material

Assessment Aspect	Validity Score	Criteria
Content Suitability	93%	Very Valid
Language Clarity	90%	Very Valid
Presentation	95%	Very Valid
Visual Design	87%	Very Valid
Average	91%	Very Valid

The validation results of the PjBL-STEM-based worksheets in the table obtained a validity score of 91%, categorized as very valid. Therefore, the PjBL-STEM-based worksheets developed can be utilized in Biology learning.

DISCUSSION

Based on the analysis results of the validity score of PjBL-STEM-based worksheets, a validity score of 91% was obtained. Thus, the PjBL-STEM-based worksheets developed are categorized as highly valid. This assessment refers to four aspects according to (Hernawan et al., 2008), including content suitability, language clarity, presentation, and visual design.

In terms of content suitability, the PjBL-STEM-based worksheets scored 93%. Therefore, in terms of content suitability, the PjBL-STEM-based worksheets are categorized as highly valid. This indicates that the worksheets are appropriate in terms of the learning outcomes, instructional objectives, and sequence of learning objectives used. The alignment of the material delivered, compliance with the needs of teaching materials accommodating the PjBL-STEM model includes relevant learning objectives with the PjBL-STEM model, compatibility of proposed projects with STEM concepts, as well as assessment aspects suitable for the characteristics of assessment and completion of PjBL-STEM-based projects. The PjBL-STEM-based worksheets developed also align with moral and social values used in everyday life, as seen in the application of STEM concepts in daily life and consideration of environmental ethics. The PjBL-STEM-based worksheets also

provide utility in the use of technology, helping to enhance students' insight and experience in technology usage. With these explanations, the developed PjBL-STEM-based worksheets meet the criteria according to the guidelines for developing teaching materials outlined by (Hernawan et al., 2008). This is consistent with the opinion of (Aisyah et al., 2020) that teaching materials should be related to the curriculum used at the appropriate education level. According to (Arsanti, 2018), there are at least four criteria for good teaching materials, including alignment between the material and the curriculum, presentation of material in line with learning principles, good language and readability, and good visual design. This is supported by (Umbaryati, 2021) stating that worksheets are tools that can help and facilitate learning activities that create effective interactions between teachers and students.

The language component of the PjBL-STEM-based worksheets achieved a validity score of 90%, with the criteria being highly valid. This indicates that the developed PjBL-STEM-based worksheets have readability, clarity of information, compliance with Indonesian language rules, and effective and efficient language usage. Several aspects align with language guidelines in the development of teaching materials outlined by (Hernawan et al., 2008). As stated by (Moelinono et al., 2017) aspects to consider in language elements used in teaching materials include punctuation, diction, and sentence structure. Punctuation is used to create meaning, clarity, and emphasis within sentences. Diction involves the selection of words by the author to convey meaning as intended. Meanwhile, sentence structure is the method of conveying information to describe the author's feelings.

The presentation component of the PjBL-STEM-based worksheets obtained a validity score of 95%, categorized as highly valid in terms of presentation. Thus, the PjBL-STEM-based worksheets have clear learning objectives, appropriate presentation sequences, and completeness of information in each PjBL-STEM syntax presented. This aligns with the presentation component guidelines outlined by (Hernawan et al., 2008). Consistent with the opinion of (Sari, Suci Perwita; Siregar, 2020) the sequence of presenting materials is useful for determining the sequence in the learning process so that learning outcomes and objectives can be achieved by students. The developed worksheets should meet the needs of students in terms of appearance, content, and systematic format. This aligns with the opinion of (Astuti et al., 2021) in their research that several considerations in the development of teaching materials include breadth, depth, accuracy, and presentation of material.

In terms of visual design components, the PjBL-STEM-based worksheets achieved a validity score of 87%, falling into the highly valid category. This indicates that the PjBL-STEM-based worksheets are in line with the use of fonts (type and size), layout, appropriate use of illustrations and images, and compatibility with display design. This aligns with the guidelines for developing teaching materials in the visual design component outlined by (Hernawan et al., 2008). As stated by (Syabani, Darmawati, & Febrita, 2018) used in learning activities can enhance students' motivation and attract students' interest and attention in learning.

Based on the analysis results of the validity score of PjBL-STEM-based student worksheets on environmental change and preservation, a score of 91% was obtained. Therefore, PjBL-STEM-based student worksheets on environmental change and preservation have highly valid criteria and can be used in biology learning.

CONCLUSION

The implementation of the Kurikulum Merdeka requires extensive preparation. One of these is the need for teaching materials that can accommodate every demand as per the learning characteristics of the Kurikulum Merdeka. Therefore, it is necessary to develop teaching materials that can fulfill all these needs. The PjBL-STEM-based worksheets developed have a validity score of 91%. Thus, the PjBL-STEM-based worksheets fall into the category of highly valid criteria.

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