Develompment of PBL Worksheets of Environmental Changes Topic to Train the Critical Thinking Skills of 10th Grades High School Students

Pengembangan LKPD PBL Materi Perubahan Lingkungan Untuk Melatih Keterampilan Berpikir Kritis Peserta Didik Kelas X

Nur Fadiah

Biology Education, Faculty of Mathematics and Natural Science, State University of Surabaya
E:mail: nur.19053@mhs.unesa.ac.id

Reni Ambarwati

Biology Education, Faculty of Mathematics and Natural Science, State University of Surabaya
E:mail: reniambarwati@unesa.ac.id

Abstract

Student worksheets for environmental changes topic help students understand learning concepts and achieve learning goals in the new curriculum era. Apart from that, the worksheets was developed based on the phases of the Problem Based Learning) model which correlates with critical thinking skills as the basis for the ability to solve environmental changes problems. This research aims to produce PBL worksheets that are valid, practical and effective. This development research uses a 4D development model (define, design, develop, and disseminate), without disseminate stage. The validity of the student worksheets is reviewed based on validation results by topic expert lecturers and media experts. The practicality of the student worksheets was reviewed based on the responses of teachers (n=3) and students (n=20). The effectiveness of the student worksheets is reviewed based on student learning outcomes in the form of pre-test and post-test as well as the achievement of critical thinking indicators. Data was analyzed quantitatively descriptively. The research results show that the student worksheets developed is very valid with a validation score of 92.7%. The student worksheets developed was considered very practical with a teacher response practicality score of 92.6% and a student response practicality score of 96%. Apart from that, the student worksheets is considered very effective with an N gain score of 0.8 and a critical thinking indicator achievement score of 93.3%. Based on this, the student worksheets developed is very valid, practical and effective for use as teaching topic on environmental changes and for practicing critical thinking skills.

Keywords: validity of student worksheets, practicity of student worksheets, effectivity of student worksheets, quality of education

Abstrak

Lembar Kerja Peserta Didik (LKPD) materi perubahan lingkungan membantu peserta didik dalam memahami konsep pembelajaran dan mencapai tujuan pembelajaran di era kurikulum baru. Selain itu, LKPD dikembangkan berdasarkan fase-fase model pembelajaran PBL yang berkorelasi dengan keterampilan berpikir kritis sebagai dasar kemampuan dalam menyelesaikan suatu permasalahan perubahan lingkungan. Penelitian ini bertujuan untuk menghasilkan LKPD berbasis PBL yang valid, praktis, dan efektif. Penelitian pengembangan ini menggunakan model pengembangan 4D tanpa tahap penyebaran. Validitas LKPD dinilai berdasarkan hasil validasi oleh dosen ahli materi dan ahli media. Kepraktisan LKPD dinilai berdasarkan respons guru (n=3) dan peserta didik (n=20). Keefektifan LKPD dinilai berdasarkan hasil belajar siswa berupa pre-test dan post-test serta ketercapaian indikator berpikir kritis. Analisis data yang telah dihasilkan menggunakan deskriptif kuantitatif. Hasil penelitian menunjukkan bahwa LKPD yang dikembangkan sangat valid dengan skor validasi sebesar 92,7%. LKPD yang dikembangkan dinilai sangat praktis dengan skor kepraktisan respons guru sebesar 92,6% dan skor kepraktisan respons peserta didik sebesar 96%. Selain itu, LKPD dinilai sangat efektif dengan skor N gain sebesar 0,8 dan skor ketercapaian indikator berpikir kritis sebesar 93,3%. Berdasarkan hal tersebut, LKPD yang dikembangkan sebagai bahan ajar yang sangat valid, praktis dan efektif.

Kata Kunci: *validitas LKPD, kepraktisan LKPD, keefektifan LKPD, kualitas pendidikan*

INTRODUCTION

Education has a crucial role. The implementation of education is always related to the following three components: curriculum, learning process, and evaluation (Amalia & Widayanti, 2012). In the 21st-century era of skills development, humans must have several abilities, including problem-solving, innovation, collaboration, and communication, to become quality and competitive individuals (Kivunja, 2015). A way to improve the quality of education is by carrying out continuous curriculum updates (Wiyono, 2018). In the 2022-2023 academic year, a new curriculum, namely the independent curriculum, has been implemented. The independent curriculum is a new policy program of the Republic of Indonesia (Kemendikbud RI).

It is crucial to teach environmental change material to students to build awareness of preserving the environment from an early age (Margareta & Purnomo, 2018). Environmental change material is essential to teach so that students can solve environmental problems and the impacts caused by using the PBL model (Saputra & Kuntjoro, 2019). PBL is a model based on factual problems to support problem-solving, intellectual, critical thinking, collaboration skills, and social attitudes (Hamruni, 2011). The PBL model correlates with critical thinking when students solve problems and provide solutions (Fitriyah & Ghofur, 2021).

Critical thinking is a mental activity to evaluate a statement's truth. Generally, the evaluation ends with a decision to accept, deny, or doubt the statement's truth (Zubaidah, 2010). Students must have several indicators of critical thinking skills, including analysis, interpretation, evaluation, explanation, inference, and self-regulation (Facione, 2015). According to research by Susilawati et al. (2020), 21% of students have moderate critical thinking skills, 64% have low critical thinking skills, and 15% have deficient critical thinking skills. The results of similar research are that the average percentage of students' critical thinking abilities is 35.41%, so students' critical thinking abilities still need to be trained in learning (Permata et al., 2019).

Student worksheets is a process activity sheet in learning to help students discover and understand concepts with clear instructions to train critical thinking skills in completing tasks according to learning indicators (Firdaus & Wilujeng, 2018). Several studies regarding PBL student worksheets on environmental change material, namely Saputra and Kuntjoro (2019) developed PBL student worksheets to train critical thinking skills, Syamsi and Fitrihidajati (2021) developed PBL student worksheets to train critical thinking skills, Fadhil and Kuntjoro (2021) developed student worksheets integrated environmental care attitude based on PBL to train problem-solving skills.

However, PBL student worksheets still needs to develop to train critical thinking skills using all the sub-materials contained in the environmental change material. Research by Saputra and Kuntjoro (2019) developed a PBL student worksheets to train critical thinking skills on pollution topics, while Syamsi and Fitrihidajati (2021) developed a PBL student worksheets to train critical thinking skills on the topic of Phytoremediation and the use of weeds.

Based on this background explanation, this research aims to produce PBL student worksheets are valid, practical, and effective for training the critical thinking skills of class X students.

METHOD

This research is a type of development research where the development carried out is the development of PBL student worksheets, which refers to the 4D development model without disseminate stage. The student worksheets development stage was carried out in the Biology Department, FMIPA, Surabaya State University, and the limited trial stage was carried out with 20 students at SMA Negeri 1 Puri Mojokerto class X even semester 2022-2023 on 21 and 22 June 2023.

At the define stage, activities are carried out to find problems and conditions that drive product development activities by observing schools. The design (planning) stage is carried out by designing PBL student worksheets by the PBL model learning steps. The development stage aims to produce student worksheets with an initial design, which is then revised based on suggestions from biology lecturers (Draft I), reviewed by expert lecturers (Draf II), validated by expert lecturers (Draft III), and tested limited to students. (Draft IV) Moreover, it produces valid, practical, and effective PBL student worksheets.

$$\text{Validity score} = \frac{\sum \ score \ obtained}{\sum \ score \ maximal} \ x \ 100\% \dots \dots \dots (1)$$

Interpreting the student worksheets validity score is declared valid with the following criteria.

Table 1. Validation Scores Interpretation Criteria

Percentage	Criteria
75,01% - 100%	Very Valid
50,01% - 75%	Valid
25,01% - 50%	Less Valid
01,00% - 25%	Invalid

The student worksheets response data analysis technique is determined by counting the number of teachers/students who answered "Yes." Response data analysis is presented in assessment percentages calculated using the formula:

$$\text{Teacher/Student response (\%)} = \frac{teachers \ or \ students \ who \ answered \ "Yes"}{teachers \ or \ students \ (totals)} \ x100\% \dots \dots (2)$$

The percentage values obtained are then interpreted with the following response scores based on the analysis results.

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Table 2. Criteria for Interpreting Response score

Percentage	Criteria
75,01% - 100%	Very Practical
50,01% - 75%	Practical
25,01% - 50%	Less Practical
01,00% - 25%	Not Practical

The test question analysis technique is determined by measuring learning outcome data from the pre-test and post-test questions. The data is analyzed quantitatively with the following formula.

$$\text{Students result score} = \frac{\Sigma\ score\ obtained}{\Sigma\ maximum\ score}\ x\ 100\%..........(3)$$

A student's test results are said to be complete if they get a test score $\geq$ 78 by the Minimum Completeness Criteria (*KKM*) based on the target school. Furthermore, increasing learning outcomes can use the Gain method. Gain is the difference between the pre-test score and the post-test score. Gain is calculated using the following formula.

$$Gain\ (g) = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score}.............(4)$$

Based on the results of the Gain value obtained, it is then interpreted with a Gain value classification score in Table 3. The student worksheets is declared effective if the Gain value is more than 0.7.

Table 3. Classification of Gain

Gain	Category
0,7<g<1	High
0,3≤g<0,7	Medium
0≤g<0,3	Low

Apart from that, an analysis of the achievement of critical thinking indicators was also carried out by calculating the average score obtained by students in each critical thinking indicator contained in each pre-test and post-test question number. Critical thinking skills indicators are said to be achieved if the average score for each indicator is complete (scoring ≥78).

RESULTS AND DISCUSSION

Research on the development of PBL student worksheets refers to the 4D development model without disseminate stage. The development of PBL student worksheets, which include interpretation, analysis, evaluation, inference, explanation, and self-regulation. This research produces valid, practical, and effective PBL student worksheets based on validity results by expert lecturers, student, and teacher response results, as well as student learning outcomes (post-test).

At the student worksheets development stage, several aspects still have shortcomings and need to be improved, including changing the color of the letters and adding an identity to the student worksheets cover; the PBL model phase is complemented and changed to be more attractive by adding color, the student worksheets features are being changed to be more attractive by adding appropriate colors and icons, as well as changes to the answer column to make it simpler.

Table 4. PBL Student Worksheets Feature on Environmental Change Material

Feature	Explanation
AYO BACA!	A feature that facilitates students to read information about material to broaden their insight: this feature trains interpretation skills.
AYO AMATI!	A feature that facilitates students to analyze information, data, and statements: this feature trains analytical skills.
AYO DISKUSI!	A feature that facilitates student discussion. this feature trains evaluation skills.
AYO KERJAKAN!	A feature that facilitates students to answer questions and simultaneously train them to think: this feature trains inference skills.
AYO SIMPULKAN!	A feature that contain statements in the form of conclusions from the results of activities that have been carried out: this feature trains explanation skills.
AYO LAPORKAN!	A feature that facilitates students to communicate the results of activities they have carried out: this feature trains self-regulation skills.

Student worksheets were developed using the PBL model and critical thinking indicators. Critical thinking indicators in this student worksheets are included in each student worksheets feature, including the Ayo baca! which facilitates students to read information about a material and practice interpretation skills. Ayo amati! this facilitates students to analyze information and practice analytical skills, the Ayo diskusi feature! which accommodates student discussions and trains evaluation skills, the Ayo kerjakan! feature this facilitates students to work on questions and practice inference skills; the Ayo simpulkan! it contains statements in the form of conclusions, practicing explanation skills, and the Ayo laporkan! feature which facilitates students to communicate the results of the activities they have carried out. This feature trains self-regulation skills.

Table 5. Data on the Validity of PBL Student Worksheets Results on Environmental Change Topic

Numb.	Aspect	Skor		Percentage (%)	Category
		V1	V2		
A. Presentation Component					
1	Physical form of student worksheets	4	3	87,5	VV
Numb.	Aspect	Skor		Percentage (%)	Category	Numb.

		V1	V2		
2	Suitability of the type and size of leICers on student worksheets	4	3	87,5	VV
3	Images help in conveying informations and investigations	4	3	87,5	VV
4	Page numbering on student worksheets	4	4	100	VV
Average				90,6	VV
B. Content Component					
5	Material in accordance with the learning achievements	3	4	87,5	VV
6	Material in accordance with the concept	4	4	100	VV
7	Completeness of worksheets	4	4	100	VV
8	Suitability with PBL model	3	4	87,5	VV
9	Achievement of critical thinking indicators	4	3	87,5	VV
10	References	4	4	100	VV
Average				93,8	VV
C. Linguistic Component					
11	The sentence used are easy to understand	4	3	87,5	VV
12	The sentence does not contain double meaning	4	4	100	VV
Average				93,8	VV
The average of all components				92,7	VV

Explanation:

V1: Validator 1

V2: Validator 2

VV: Very Valid

Research on the development of PBL student worksheets refers to the 4D development model without disseminate stage. The development of PBL student worksheets aims to train critical thinking skills, which include interpretation, analysis, evaluation, inference, explanation, and self-regulation. This research produces valid, practical, and effective PBL student worksheets based on validity results by expert lecturers, student, and teacher response results, as well as student learning outcomes (post-test). The appearance of the PBL student worksheets produced is presented in Table 4.

At the student worksheets development stage, several aspects still have shortcomings and need to be improved, including changing the color of the letters and adding an identity to the student worksheets cover; the PBL model phase is complemented and changed to be more attractive by adding color, the student worksheets features are being changed to be more attractive by adding appropriate colors and icons, as well as changes to the answer column to make it simpler.

Based on the validation results of the PBL student worksheets in Table 5, an assessment of the validity of the student worksheets was produced based on three components: the presentation component, the content component, and the linguistic component. The presentation component produced an average of 90.6%; The content component produced an average of 93.8%, and the language component produced an average of 93.8% so that the overall average of the assessment components was 92.7%, which was then interpreted into validation score criteria which produced very valid criteria. Validators also provide input and suggestions so that the student worksheets that has been developed can be improved into a beICer learning tool.

Table 6. Data on the Results of Teacher (n=3) and Student(n=20) Responses to the Student Worstheet Environmental Change Topic

Numb.	Components	Percentage Positive Respons (%)	
		Teachers (n=3)	Students (n=20)
A. Readability Criteria			
1.	The words on the student worksheets are easy to read	100	100
2.	Images are clear	67	95
3.	The sentence on the student worksheets are easy to understand	100	85
4.	Information on images can make it easier to carry out investigations	100	90
Average		91,7	92,5
B. Presentation Criteria			
5.	The display on the student worksheets is interesting	100	100
6.	The images displayed on the student worksheets corresponds to the material	100	100
7.	The order of the material presented is easy to learn	100	100
8.	The student worksheets make learing activity interesting	67	95
Average		91,7	98,7
C. Content Criteria			
9.	Explanation of the material is easy to understand	100	100
10.	Instuctions for using students worksheet are easy to learn	100	95
11.	The material presented is interesting.	67	90
Average		89	95
D. Linguistic Criteria			

12.	The language used is easy to understand	100	100
13.	The terms used are easy to understand	67	80
Average		83,5	90
E. PBL Models Criteria			
14.	The student worksheets developed orient students towards problems	100	100
15.	The student worksheets developed organice students to learn	100	100
16.	The student worksheets developed facilitate students carrying on investigations	100	100
17.	The student worksheets developed helps students to develop and present results	100	100
18.	The student worksheets developed helps students evaluate the results of problem solving	100	100
Average		100	100
F. Critical Thinking Indicators Criteria			
19.	The student worksheets developed facilitate students interpretation	100	100
20.	The student worksheets developed facilitate students analysis	100	100
21.	The student worksheets developed facilitate students evaluation	100	100
22.	The student worksheets developed facilitate students inference	100	100
23.	The student worksheets developed facilitate students explaination	100	100
24.	The student worksheets developed facilitate students self-regulation	100	100
Average		100	100
Overall Average		92,6	96
Category		Very Practical	Very Practical

Based on the results in Table 6., which is assessed based on six criteria: readability criteria, presentation criteria, content criteria, linguistic criteria, PBL model criteria, and critical thinking indicator criteria. In the results of teacher responses to PBL student worksheets with readability criteria, the average positive response was 91.7%; presentation criteria resulted in an average positive response of 91.7%; content criteria produced an average positive score of 89%; linguistic criteria produced an average positive response of 83.5%; PBL model criteria produced an average positive response of

100%; and critical thinking indicator criteria produced an average positive response of 100%. From the average positive response for each criterion, an overall average of 92.6% was produced, which was then interpreted into the practicality score criteria to produce efficient criteria.

In the results of students' responses to PBL student worksheets with readability criteria, an average positive response was 92.5%; presentation criteria resulted in an average positive response of 98.7%; content criteria produced an average positive score of 95%; linguistic criteria produced an average positive response of 90%; PBL model criteria produced an average positive response of 100%; and critical thinking indicator criteria produced an average positive response of 100%. From the average positive response for each criterion, an overall average of 96% was produced, which was then interpreted into the practicality score criteria to produce efficient criteria.

Table 7. Data on Student Learning Outcomes

Stude nts	Pre-test		Post-test		N gain	Category
	S	C	S	C		
1	62	IC	97	C	0,9	High
2	67	IC	87	C	0,6	Medium
3	50	IC	93	C	0,9	High
4	60	IC	90	C	0,8	High
5	67	IC	94	C	0,8	High
6	79	C	93	C	0,7	Medium
7	62	IC	93	C	0,8	High
8	80	C	100	C	1,0	High
9	74	IC	94	C	0,8	High
10	53	IC	90	C	0,8	High
11	74	IC	100	C	1,0	High
12	80	C	97	C	0,9	High
13	71	IC	93	C	0,8	High
14	79	C	97	C	0,9	High
15	60	IC	90	C	0,8	High
16	71	IC	90	C	0,7	High
17	60	IC	93	C	0,8	High
18	71	IC	93	C	0,8	High
19	74	IC	94	C	0,8	High
20	74	IC	89	C	0,6	Medium
Overall average	68,4		93.3		0,8	High
C	20%		100%			

Explanations:

S: Score   C: Complete

C: Completeness   IC: Incomplete

Based on the learning outcomes data for class, Learning outcomes are declared complete if they get a score above the Minimum Completion Criteria (*KKM*), adjusted to the school, namely 78. Completed pre-test scores consist of four students, while incomplete pre-test scores consist of 16 students. So, the percentage of

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completeness of students' pre-test scores is 20%. The completed post-test scores consisted of all students. So, the completion percentage of students' pre-test scores is 100%.From these questions, there is an increase in student learning outcomes from pre-test scores to post-test scores. The increase in student learning outcomes is measured using N gain, which produces an overall average of 0.8 in the high category.

In addition to the data obtained from the students' learning results through the pre-test and post-test, the effectiveness of student worksheets can also be obtained from the acquisition of critical thinking indicators in the pre-test and post-test questions. Below are the results of the analysis of the achievements of critical thinking indicators in Table 8.

Table 8. Data on the Results of Achieving Critical Thingking Indicators

Numb.	Indicator	Pre-test		Post-test	
		Achievement (%)	Category	Achievement (%)	Kategori
1.	Interpretation	78	C	90	C
2.	Analysis	78	C	92	C
3.	Evaluation	77	IC	97	C
4.	Inference	64	IC	93	C
5.	Eksplanation	66	IC	94	C
6.	Self-regulation	70	IC	94	C
Overall average (%)		72,2		93,3	
Category		IC		C	

Explanation:

C: Complete

IC: Incomplete

Based on the data in Table 8, there is an increase in the critical thinking indicator completion scores in the pre-test and post-test questions. Critical thinking indicators used in pre-test and post-test questions include interpretation, analysis, evaluation, inference, explanation, and self-regulation. The indicator completeness score is calculated from the average results of each indicator by all students. In the pre-test questions, a completeness score for the interpretation indicator was 78%, the analysis indicator was 78%, the evaluation indicator was 77%, the inference indicator was 64%, the explanation indicator was 65%, and the self-regulation indicator was 70%. From the completeness score for each critical thinking indicator, two critical thinking indicators are included in the complete category and four in the incomplete category. Apart from that, the completeness score resulted in an overall average score of 72.2%, which was interpreted using the school's *KKM* score (78%) to include this score in the incomplete category.

In the post-test questions, a complete score for the interpretation indicator was 90%, the analysis indicator was 92%, the evaluation indicator was 97%, the inference indicator was 93%, the explanation indicator was 94%, and the self-regulation indicator was 94%. The completeness score for each critical thinking indicator shows that all critical thinking indicators are included in the complete category. Apart from that, from the completeness value, the overall average value of the indicators was 93.3%, which was included in the complete category.

The validity of the student worksheets developed is assessed from three components: presentation, content, and linguistic. The assessment of student worksheets based on presentation, content, and language components resulted in an average validity score of 92.7% in the very valid category. The presentation component obtained an average of 90.6%, included in the very valid category. Obtaining a relatively high percentage of validity was because, during the development stage, supervisors and examiners gave researchers a lot of input and suggestions to improve the student worksheets by using language, vocabulary, and sentence structure that could be understood. Apart from that, using printed leICers, writing sentences, and providing pictures to convey the message (Sabilah, 2016).

The content component obtained an average of 93.8%, included in the very valid category. The percentage obtained was relatively high because, at the student worksheets development stage, researchers carried out curriculum analysis (Learning Outcomes and Flow of Learning Objectives), determined the student worksheets title and subject matter, determined assessment tools, and compiled student worksheets by paying attention to the structure (Prastowo, 2014). The content aspect is crucial because it can be used to determine students' abilities (Novitasari & Puspitawati, 2022).

The material developed in this student worksheets is environmental change, which includes four sub-materials: facts about environmental change, the impact of environmental change, human activities that cause environmental change, and solutions to overcome it (Puspaningsih et al., 2021). Descriptions of material and information regarding the facts and impacts of environmental change are contained in student worksheets 1. In contrast, descriptions of material and information regarding human activities that cause environmental changes and efforts to overcome them are contained in student worksheets 2.

The student worksheet developed consists of the title and cover of the student worksheets, study instructions, learning objectives by learning outcomes, supporting information and sources, and tasks and work steps. (Prastowo, 2013) the criteria for a good student worksheets include a title, study instructions, primary material covered, supporting information, tasks or work steps, and evaluation. Apart from that, student worksheets is also by the PBL model because student worksheets is structured based on five PBL phases. The

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phases in the PBL model are very suitable for training students' critical thinking skills because problem-solving requires high critical thinking skills (Draghicescu, 2014).

The six features in the student worksheets include *Ayo baca!, Ayo amati!, Ayo diskusi!, Ayo kerjakan!, Ayo simpulkan!,* and *Ayo laporkan*! This student worksheets has features that can help train students' critical thinking skills. These features are adjusted to the number of critical thinking skills indicators, consisting of six indicators. The ability to recognize and define problems, make careful observations, be curious, present relevant questions, use various sources to obtain facts, and make wise decisions (Sani, 2019).

The linguistic component obtained an average of 93.8%, included in the very valid category. Obtaining a reasonably high percentage shows that the language prepared is under excellent and correct grammatical rules so that the sentences in the student worksheets are easy to understand. Apart from that, language can be used to convey information to make it easier to understand the information (Muhammad & Ambarwati, 2021). Therefore, the language used in the student worksheets is made by grammatical rules and does not contain double meanings that give rise to doubts or elements of SARA. The choice of words in writing student worksheets is an essential factor in the language aspect (Pertiwi, 2019).

The practicality of the student worksheets results from the response of teachers and students to the student worksheets that has been developed. student worksheets can be practical if it meets criteria including readability, presentation, content, language (Muslimah & Ambarwati, 2023), compatibility with the PBL model, and compatibility with critical thinking indicators. From each percentage of positive responses from teachers and students to the practicality criteria of student worksheets, the overall average positive response from teachers was 92.6%, and the average overall positive response from students was 96%. Second, the overall average percentage of positive responses to the student worksheets practicality criteria is included in the efficient category.

Based on the readability criteria, the percentage of positive responses from teachers was 91.7%, while the percentage of positive responses from students was 92.5%. The percentage of positive responses obtained was classified as very practical, even though the photo on the student worksheets was less readable because it broke when printed, thus slightly affecting students in carrying out investigations. Based on this, there is a suggestion from the biology subject teacher as follows: "The picture is corrected and replaced with a clearer picture to make it easier for students to analyze." This aligns with the low image resolution affecting the information identification process (Sabotttke & Spieler, 2020).

The percentage of presentation criteria resulting from positive teacher responses was 91.7%, while the percentage of positive responses from students was 98.7%. The percentage of content criteria resulting from positive teacher responses was 89%, while the percentage of positive responses from students was 95%. On the student worksheets point making learning activities attractive and the student worksheets material point interesting, one teacher responded negatively, resulting in a percentage of 67%. Then improvements were made to the student worksheets so that at that point, it received a positive response from students of 95% and 90%, which was supported by the following statement: "The student worksheets is good and attractive because of the choice of colors which makes me interested in reading and studying" The percentage of positive responses produced is classified as in the efficient category because students will be interested if the presentation aspect is interesting (Iswantini, 2017). More than 80% of visual information is related to color as an information carrier (Lewandowska & Krugly, 2022). Additionally, interactive learning can attract students' curiosity because there are innovations (Damayanti, 2020).

The linguistic criteria resulted from positive teacher responses of 83.5%, while the percentage of positive responses from students was 90%. The percentage obtained for the language criteria is classified in the efficient category, according to the statement by Nirwana & Puspitawati (2021), that suitable and correct Indonesian can help students respond quickly and understand the information obtained. When the terms in the student worksheets were easy to understand, one teacher and four students gave negative responses, so the percentages were 67% and 80%. Teacher respondents also commented: "Some of the terms used are still difficult to understand when given to high school students." Apart from that, there were comments from students as follows: "The explanation of scientific terms is further explained." Using sentences that suit students' abilities can make it easier to understand the material (Junita & Yuliani, 2022).

Apart from that, several words are difficult for students to understand because the choice of words is not appropriate and is still rarely known to students. The use of language requires an emphasis on informative language so that the delivery of the material can be accepted, as well as the use of familiar language so that it is readily accepted by students (Arsena & Rahayu, 2022). The use of sentences must be adjusted to the student's abilities because sentences that are too long tend to be challenging to understand (Fatin, 2017). The use of terms must be adjusted to the level targeted in delivering the material so students can accept it (Arsena & Rahayu, 2022). So, it is necessary to improve the student worksheets by including a glossary as an explanation for terms that are difficult to understand.

The criteria for the PBL model are generated from positive responses from teachers and students based on the phases in the PBL model. The percentage of positive responses from teachers and students resulted in a score

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of 100%, and this is because, in the student worksheets, there are phases of the PBL model that are arranged sequentially. In addition, critical thinking indicator criteria are generated from positive responses from teachers and students based on six critical thinking indicators (Facione, 2013). The percentage of positive responses from teachers and students produces a score of 100%, and this is because, in each phase of the PBL model, there are features that are adjusted based on indicators of critical thinking skills. High-level critical thinking activities include problem-solving, problem discovery, giving opinions, making decisions, criticizing, and classifying (Torff, 2011). Apart from that, several words are difficult for students to understand because the choice of words is not appropriate and is still rarely known to students. The use of language requires an emphasis on informative language so that the delivery of the material can be accepted, as well as the use of familiar language so that it is readily accepted by students (Arsena & Rahayu, 2022). The use of sentences must be adjusted to the student's abilities because sentences that are too long tend to be challenging to understand (Fatin, 2017). The use of terms must be adjusted to the level targeted in delivering the material so students can accept it (Arsena & Rahayu, 2022). So, it is necessary to improve the student worksheets by including a glossary as an explanation for terms that are difficult to understand.

The criteria for the PBL model are generated from positive responses from teachers and students based on the phases in the PBL model. The percentage of positive responses from teachers and students resulted in a score of 100%, and this is because, in the student worksheets, there are phases of the PBL model that are arranged sequentially. In addition, critical thinking indicator criteria are generated from positive responses from teachers and students based on six critical thinking indicators (Facione, 2013). The percentage of positive responses from teachers and students produces a score of 100%, and this is because, in each phase of the PBL model, there are features that are adjusted based on indicators of critical thinking skills. High-level critical thinking activities include problem-solving, problem discovery, giving opinions, making decisions, criticizing, and classifying (Torff, 2011).

Student worksheets developed and validated are then tested on a limited basis to determine the effectiveness of PBL student worksheets. Student worksheets can be effective if it produces a high N gain and increases student learning outcomes in the form of pre-test and post-test questions. Apart from that, the pre-test and post-test scores are also interpreted into completion criteria based on the *KKM* score at the school concerned, namely 78; if the score obtained is ≥78, then it can be said to be complete. The average pre-test and post-test scores differ in achieving learning objectives (Rizki et al., 2016).

From the pre-test scores, there were 20% who could be said to have completed. Meanwhile, in the post-test questions, it can be seen that 100% can be said to have completed it. The overall average N gain from the pre-test and post-test scores is 0, 8, which is included in the high category. Therefore, PBL student worksheets is very effective for training the critical thinking skills. PBL student worksheets can make students more active during learning, encourage thinking skills, and apply a scientific attitude (Banjarani et al., 2020).

Apart from being seen from students' learning outcomes, student worksheets can be said to be effective in training students' critical thinking skills; it can also be seen from the results of achieving critical thinking indicators in the pre-test and post-test questions. The pre-test and post-test questions were created based on six critical thinking indicators in each question number. From the average results of each indicator, an overall average of 72.2% was obtained in the incomplete category. In the post-test questions, the overall average indicator was 93.3% in the complete category. From the results of achieving critical thinking indicators, there was an increase from the pre-test score to the post-test score after limited testing of the student worksheets.

PBL student worksheets effectively trains critical thinking skills. The PBL approach is primarily designed to develop student' thinking and problem-solving skills (Arends, 2008). Through critical thinking, students are invited to take an active and influential part in building their own knowledge or intellectual structure and apply it to solve their problems (William, 2010).

CLOSING
Conclusion
Based on the results of research on the development of PBL student worksheets, it can be concluded that the PBL student worksheets, which was developed is said to be very valid with a percentage of 92.7%. The practicality of the PBL student worksheets, which was developed, is very valid, with a percentage of 92.7%. The effectiveness of the PBL student worksheets is 93.3%.

Suggestion
For future research, it was namely implementing PBL student worksheets on environmental change material to train students' critical thinking skills to solve problems and provide appropriate solutions.

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