Al-Jahiz: Journal of Biology Education Research
ISSN 2722-5070 (Print) ISSN 2722-5275 (Online)
Vol. 6 No. 2 July-December 2025
Available online at:
http://e-journal.metrouniv.ac.id/index.php/Al-Jahiz

Development of a Problem-Based Instruction Student Worksheet on Environmental Change to Improve Senior High School Students' Scientific Literacy

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Article information

Riwayat article:
Accepted: July 2, 2025
Revised: September 24, 2025
Published: November 4, 2025

Keywords:
Student worksheet, *Problem - based instruction*, Science literacy, 21st century education

ABSTRACT

This research aims to develop PBI-based student worksheet to improve science literacy and critical thinking of high school grade X students. The research method uses the Plomp Research and Development (R&D) model which consists of initial investigation, design, and evaluation stages. Formative evaluation refers to the Tessmer model, including self-evaluation, expert review, one-to-one, small group, and field test. The instruments used included validation sheets, response questionnaires, and science literacy ability tests. The subjects of the study were 29 students divided into experimental and control classes. The validation results showed that student worksheet was very valid (average score of 87.5%), practical (student and teacher response ≥85%), and effective in improving science literacy. The increase in science literacy gain score was 0.48 (experimental class) and 0.36 (control). The t-test showed significant differences between groups ($p < 0.05$). Thus, PBI-based student worksheet is suitable for use as a learning medium to improve students' 21st century skills.

How to Cite
Ilahi, T, A., Irdawati, Ahda, Y., Arsih, F., & Fajrina, S. (2025). Development of a Problem-Based Instruction Student Worksheet on Environmental Change to Improve Senior High School Students' Scientific Literacy. *Al Jahiz: Journal of Biology Education Research*. 6(2), 259–278. DOI: https://doi.org/10.32332/al-jahiz.v6i2.11159.

Published by
Al-Jahiz: Journal of Biology Education Research
Website
https://e-journal.metrouniv.ac.id/index.php/Al-Jahiz/index

INTRODUCTION

Education is a strategic means in forming a generation that is not only cognitively capable, but also possesses scientific competence and high literacy to respond to the challenges of the 21st century. In the 21st century, education plays a strategic role in preparing a generation that is not only cognitively capable but also scientifically literate to face global challenges. Learners are expected to master essential 4C skills critical thinking, creativity, collaboration, and communication while also developing strong scientific and technological literacy. These competencies are

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particularly important in the context of the Industrial Revolution 4.0 and Society 5.0, where citizens must be able to make informed scientific decisions in daily life (Nurhayati *et al.*, 2024; OECD, 2019). One of the key competencies in today's global era is science literacy, which includes not only mastery of scientific concepts, but also the ability to interpret data, evaluate evidence-based information, and understand the relationship between science and social reality (OECD, 2019; Nurhayati *et al.*, 2024). Science literacy has become increasingly important in the era of the Industrial Revolution 4.0 and *Society* 5.0 which demands that citizens be active and able to make scientific decisions in daily life.

Unfortunately, data shows that the science literacy skills of Indonesian students are still below the international average. The 2018 PISA results show that Indonesia ranks 71st out of 79 countries with an average science literacy score of 396, far below the Organisation for Economic Co-operation and Development (OECD) average of 489 (OECD, 2019). The results of empirical studies in secondary schools in Indonesia show that students' low science literacy is correlated with the dominant learning approach that is teacher-centered and does not support scientific exploration activities Ningsih *et al.*, (2020). This indicates the need for innovative approaches that allow learners to learn actively and contextually.

This problem was also found in real life at SMA Negeri 5 Sungai Penuh as the location of this research. Based on the results of the questionnaire distributed to grade X students in May 2025, it is known that the majority of students show a low level of science literacy. The results of the recapitulation of the Science Literacy Ability Questionnaire Score for Class X students can be seen in table 1 below:

Table 1. Results of the Recapitulation of Science Literacy Ability Questionnaire Scores for Class X Students

Aspects	Category	Class	Number of Students	Percentage (%)
Science Literacy	Very Low	A	1	3,45%
		B	0	0%
	Low	A	17	58,62%
		B	18	62,07%
	Keep	A	11	37,93%
		B	11	37,93%
	Tall	A	0	0%
		B	0	0%

Source*:* The results of a questionnaire given by the researcher to class X students of SMA Negeri 5 Sungai Penuh in May 2025.

These findings indicate that biology learning remains conventional and lecture-centered, which limits opportunities for students to engage in higher-order scientific practices such as data

interpretation, problem-solving, and reflective discussion. This condition suggests that students have limited readiness to develop scientific literacy skills, as the existing learning process does not sufficiently train their scientific thinking habits or provide contextualized problem-solving experiences. In addition, the student worksheet currently used is mainly procedural and does not support the development of scientific literacy skills in a contextual way. To address these instructional gaps, the Problem-Based Instruction (PBI) model offers a relevant solution. By using real-life problems as the starting point of learning, PBI encourages students to think scientifically, explore information, engage in discussion, and find solutions through investigative processes (Ramadhan et al., 2023). Previous studies also confirm that PBI can enhance scientific literacy by promoting active and reflective learning activities (Öztürk et al., 2021; Amaliyah et al., 2022). However, studies that specifically develop teaching tools such as PBI-based student worksheet in the context of environmental change materials at the high school level, with a focus on improving science literacy systematically and measurably, are still very limited. Previous studies have focused more on the general influence of PBI on learning outcomes without paying attention to instructional design in the form of student worksheet that is integrated with science literacy goals.

On the other hand, the implementation of the Independent Curriculum which emphasizes project- and problem-based learning as a reinforcement of the Pancasila Student Profile further strengthens the urgency of developing innovative learning media based on PBI (Kemendikbudristek, 2022). Therefore, the development of student worksheet is based on *Problem-Based Instruction* In biology learning, especially in environmental change materials, it is a strategic effort and is based on contextual, pedagogical, and national education policy needs. This research aims to answer this gap and contribute to the development of science literacy of high school students in a concrete way.

According to the OECD (2019), scientific literacy is the ability of individuals to engage in issues related to science and scientific ideas, as critical members of society and able to make decisions based on scientific studies. Scientific literacy not only includes understanding scientific concepts, but also includes the ability to interpret data, disseminate evidence-based arguments, and convey scientific knowledge to everyday life (Resi *et al.*, 2023). In the context of Biology learning, strengthening scientific literacy is needed so that students can understand and analyze environmental phenomena critically and relevantly (Sihombing *et al.*, 2024).

PBI is a learning model that focuses the learning process on solving real problems through the stages of problem identification, investigation, group discussion, and reflection as an effort to

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strengthen conceptual understanding. This approach places students as active subjects who analyze problems and find solutions based on data and scientific evidence. PBI has been proven effective in improving critical thinking skills and student learning outcomes. In addition, this approach also encourages a significant increase in scientific literacy in the context of Biology learning (Wardani *et al*., 2023) The development of PBI-based student worksheet is also in line with the Merdeka Curriculum policy which emphasizes the importance of project-based learning and problem solving. This aims to form a Pancasila Student Profile that thinks critically, independently, and adaptively to future challenges (Kemendikbudristek, 2022).

In line with this urgency, the development of innovative learning media is a strategic step to overcome the low science literacy skills of students. One form of effective media is the Student Worksheet which is designed based on the Problem-Based Instruction (PBI) approach. student worksheet not only serves as a guide for learning activities, but can also be a means to instill scientific thinking processes through exploration, problem-solving, and reflection on contextual phenomena. By integrating the principles of PBI into the structure of the student worksheet, students are encouraged to actively engage in the learning process, connect science concepts with daily life, and build more meaningful scientific understanding.

However, until now, there is still limited development of PBI-based student worksheet specifically designed to improve science literacy on the topic of environmental change at the high school level. The majority of the teaching tools available are procedural, have not encouraged high cognitive engagement, and are not fully aligned with the goals of the Independent Curriculum. Therefore, this research is focused on the development of Problem-Based Instruction-based student worksheet to improve the science literacy skills of class X students of SMA Negeri 5 Sungai Penuh, as an effort to answer pedagogical needs at the educational unit level while strengthening their contribution to context-based science learning innovation.

RESEARCH METHOD

Types of Research

This research is an R&D development research that aims to produce student worksheet based on Problem-Based Instruction (PBI) to improve the science literacy skills of high school class X students on environmental change materials.

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Development model

The development model used in this study refers to Plomp, which consists of three stages, namely: (1) *Initial Investigation*, carried out to identify learning needs, analyze the characteristics of students, review the curriculum, and examine existing learning resources through observation, teacher interviews, and questionnaires; (2) *Design and Realization*, involving the preparation of a draft of the PBI-based student worksheet and the development of scientific literacy test items, validation by experts, and revisions based on feedback; and (3) *Test, Evaluation, and Revision*, which included limited trials and broader implementation to evaluate the validity, practicality, and effectiveness of the developed worksheet, followed by improvements (Plomp et al., 2013).

Development procedure

The development procedure in this study refers to the Plomp development model which consists of three main stages, and is supported by Tessmer's formative evaluation to ensure product quality. For more details, you can see Figure 1 below:

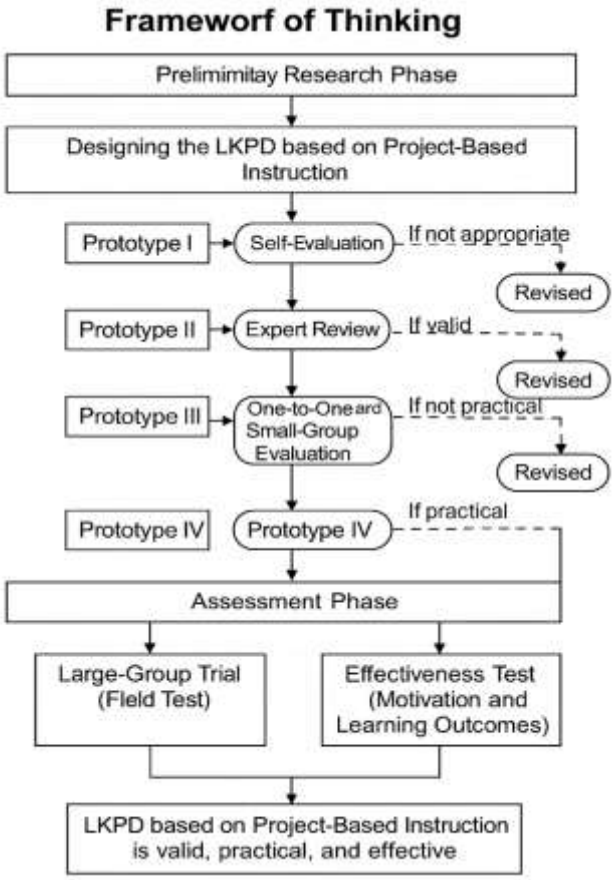

Figure 1. PBI-based worksheet development procedure on environmental change materials research subjects

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The subjects of this study were 58 grade X students of SMA Negeri 5 Kota Sungai Penuh, consisting of 29 students in the experimental class (grade X A) and 29 students in the control class (grade X B). The sampling technique applied was purposive sampling, with inclusion criteria such as comparable teacher assignments, relatively similar initial test scores, and the fact that these classes had not previously used PBI-based student worksheets. The instruments used included: (1) an expert validation questionnaire to assess content validity, construct validity, and language suitability of the worksheets; (2) a scientific literacy test consisting of 5 essay questions developed based on the PISA framework, which includes the competencies of explaining phenomena scientifically, interpreting data and evidence, and evaluating scientific investigations; (3) an assessment rubric for student responses; and (4) a student response questionnaire to measure practicality and engagement. The validity of the scientific literacy test items was confirmed through expert review, while reliability testing using ANATES software produced a Cronbach's alpha coefficient of 0.878, indicating high reliability. The difficulty level of the test items and the discriminating power were also analyzed to ensure the quality of the test.

Table 2. Student Worksheet Validity Level

Achievement Rate (%)	Category
81-100	Very valid
61-80	Valid
41-60	Quite valid
21-40	Invalid
0-20	Invalid

Source: Modified from Riduwan (2012)

The validity value is searched using the formula:

$$n = \frac{\textbf{score obtained}}{\textbf{highest number of scores}} \; x\; 100\%$$

Information:

n= number of samples

Effectiveness of student worksheet

The research design used in this study was a quasi-experimental non-equivalent control group design, as shown in Table:

Table 3. Effectiveness Trials

Class	*Pre-test*	Treatment	*Post test*
Eksperimen	T1	X (LKPD PBI)	T2
Control	T2	-	T2

Information:

Q1: Pre test Experiment class

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T2: Post test class Control

X: Treatment in the Experiment class

In addition, to provide a clearer visualization of the procedure, the timeline of the research implementation is presented in Figure 2

Flow of Effectiveness Test

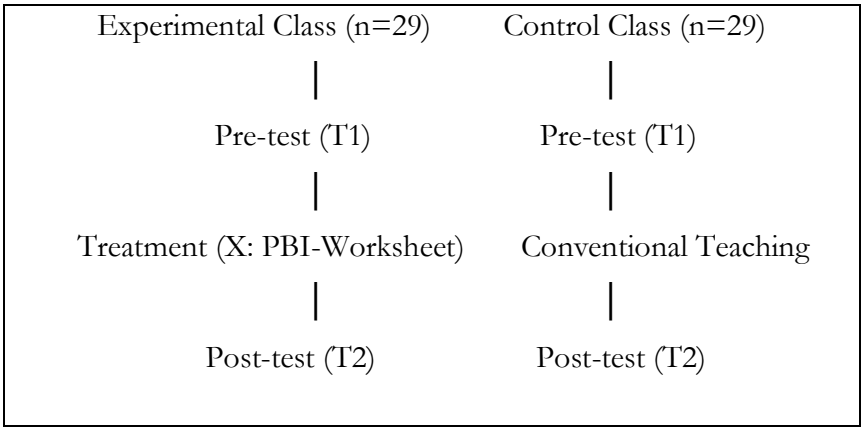

Figure 2. Timeline of the quasi-experimental research design

The effectiveness analysis was carried out using the N-Gain calculation to measure the improvement of students' science literacy:

$$\boldsymbol{n = \frac{posttest\ score - pretest\ score}{highest\ number\ of\ scores - pretest\ score}\ x\ 100\%}$$

- Normality Test: Kolmogorov–Smirnov, data are normal if p > 0.05
- Homogeneity Test: Levene's Test, data are homogeneous if $p > 0.05$
- Qualitative Analysis: Expert evaluations, teacher feedback, and student responses analyzed descriptively
- Triangulation: Comparison of N-Gain results, expert judgments, and student perceptions to validate findingsScience Literacy Assessment

The research used to see the level of science literacy of students is by using tests. The science literacy questions used consisted of 5 questions that covered three aspects of science literacy, namely context, content and science process. The value of students' science literacy ability is calculated using a percentage calculation between the correct score and the maximum number of scores (Purwanto, 2006). The criteria for assessing students' science literacy ability can be seen in the following Table 4:

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Table 4. Criteria for Assessing Students' Science Literacy

Interval	Criteria
86-100%	Excellent
76%-85%	Good
60%-75%	Enough
55%-59%	Less
≤54%	Less than once

Source: Purwanto, 2006

RESEARCH RESULTS

The results of the formative evaluation showed that expert validation obtained an average score of 91 in the very valid category, the one-to-one trial obtained a score of 90 in the very valid category, and the small group trial obtained a score of 91 in the very valid category. The results of the research conducted can be explained as follows:

1. Preliminary *Research*

Problem analysis

The results of initial observation and the distribution of questionnaires to teachers and students of class X of high school in the subject of Biology. The goal is to identify problems that arise in the learning process. The results of the observation show that the learning method used by teachers is still dominant in conventional lectures and discussions. This makes learning one-way, less actively involved students, and has not facilitated critical thinking skills and science literacy. In addition, teachers stated that they had never used Problem Based Instruction (PBI)-based teaching materials, including PBI-based student worksheet. Observation data was also strengthened by students' responses that showed that their active involvement in learning was still less than optimal. The following is a table of the results of the observation and the initial conditions:

Table 5. Results of initial observation of biology learning

No.	Observed Aspects	Conditions Found	Number of Respondents	Percentage (%)
1	Learning methods	Dominant conventional lectures and discussions	1 teacher	100%
2	Use of PBI-based student worksheet	Never used	1 teacher	50%
3	Active involvement of learners	Still low	18 students out of 29 students	62%

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The results of the table above indicate that learning activities have not fully engaged students actively. The percentage of student involvement which only reaches 62.07% indicates that there is great potential that has not been explored in the learning process.

Needs analysis

Based on the problems that have been identified, a need analysis is carried out to find out the interventions or solutions needed to improve the quality of Biology learning. This needs analysis was strengthened by quantitative data from the results of the questionnaire given to 29 students. The questionnaire is used to measure the level of need in solving students' problems in Biology learning. More details can be seen in table 6 below.

Table 6. Analysis of the Needs of Students

Category	Number of Students	Percentage (%)
Much needed	23	80%
Needed	6	20%
Total	29	100%

From Table 6, it can be seen that as many as 20% of students do not need PBI-based student worksheet in participating in the learning process. This shows that almost one-third of students need learning media that can improve science literacy.

Curriculum analysis

Curriculum analysis is carried out to ensure that the development of student worksheet is based on PBI. The curriculum that applies at SMA Negeri 5 Sungai Penuh is the Independent Curriculum. Based on the curriculum analysis conducted through interviews with teachers, the Environmental Change material is taught in class X semester 2. In this study, only one material was analyzed according to the results of the observations that had been made.

In phase E (class X of high school), the Biology Learning Outcomes emphasizes the ability of students to understand the interaction of living things and their environment, as well as the impact of human activities on the environment. One of the materials that is in accordance with this learning outcome is *Environmental Change*, because it raises actual and contextual environmental issues in daily life. Learning outcomes and learning objectives can be seen in the table below.

Table 7. Learning outcomes and objectives in the environment change material for class X of high school

Learning Outcomes	Learning Objectives
Students are able to explain various environmental changes, their causative factors, and their impact on biodiversity and human life through holistic observation and study of ecosystems.	1. Students are able to explain the meaning and forms of environmental change. 2. Students are able to identify the causes of environmental change.

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3. Students are able to analyze the impact of environmental changes on living things and ecosystems.
4. Students are able to develop solutions based on biological principles to environmental problems.

Concept analysis

Concept analysis is carried out to identify and outline the main concepts in the Environmental Change material that will be developed into PBI-based student worksheet. The purpose of this analysis is to ensure that the development of teaching tools is firmly rooted in a complete and in-depth scientific understanding and supports the strengthening of students' science literacy and critical thinking. Environmental Change materials cover a wide range of interrelated concepts, from natural changes to changes caused by human activities. These concepts include:

Table 8. Environmental change material

No.	Concept	Description
1	Environmental changes	Any form of change that occurs in the biotic and abiotic components of an ecosystem in a certain time scale.
2	Factors that cause environmental change	Natural factors (natural disasters, climate change) and human factors (deforestation, pollution, industrialization, urbanization).
3	Impact of environmental change	Negative impacts on biodiversity, ecosystem balance, human health, and quality of life.
4	Environmental pollution	The entry of substances or other components into the environment that causes damage, consists of water, air, soil, and noise pollution.
5	Waste	The rest of human activities that can pollute the environment, include organic and inorganic waste, domestic waste, agriculture, and industry.
6	Environmental conservation efforts	Mitigative and adaptive measures, such as recycling, reforestation, bioremediation, and the application of sustainable development principles.
7	Human and environmental relations	The concept of interdependence between humans and nature, including moral and ecological responsibility for the preservation of ecosystems.
8	Holistic ecosystem study	A systems approach to understanding the interactions between ecosystem components (producers, consumers, decomposers, and abiotic environments).

Student Analysis

Based on the results of the analysis of student needs visualized in the form of a bar diagram, it can be known that several important conditions related to the characteristics and learning needs of class X students of SMA Negeri 5 Sungai Penuh can be identified. This analysis includes six main aspects, namely mastery of prerequisite materials, learning interests, involvement in learning,

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dominant learning styles, science literacy skills, and access to teaching materials. More details can be seen in the diagram of the results of the distribution of questionnaires to 29 students of class X of SMA Negeri 5 Sungai Penuh below:

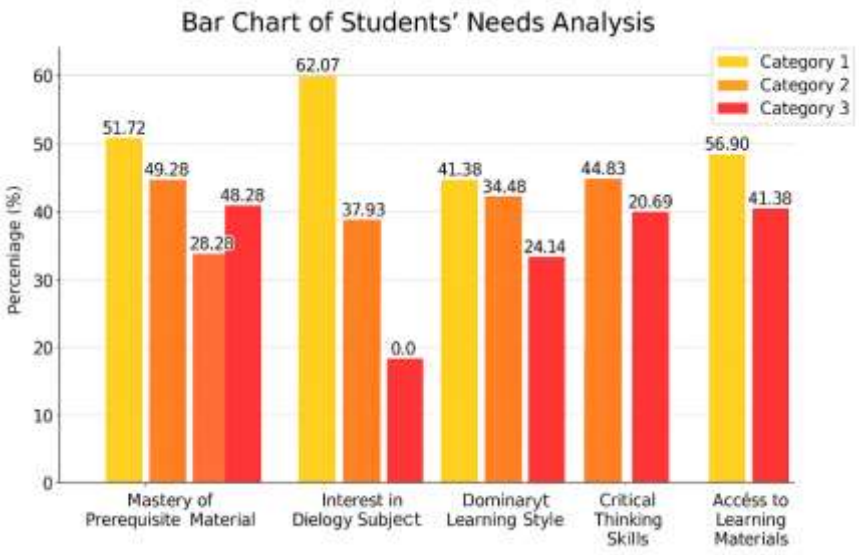

Figure 3. Diagram of results of the Student Learning Tendency Questionnaire

Based on Figure 3 above analyzing the needs of class X students of SMA Negeri 5 Sungai Penuh, there are several important findings. Some students (48.28%) have not mastered the prerequisite material, while 51.72% have mastered it. Interest in learning Biology is still relatively moderate to low (68.97%), so efforts are needed to increase learning motivation. As many as 37.93% of students are still less active in learning. The variety of learning styles is quite diverse with the dominance of visual style (41.38%), followed by kinesthetic and auditory.

2. Prototyping phase

After completing the analysis and design, the researcher then proceeded to create teaching materials in the form of PBI-based student worksheet to improve the science literacy skills of students in the context of the material on Environmental Change. The development process is carried out by following the following steps:

Front Cover

The cover section of the student worksheet PBI biology learning includes the title, images, content of the material, the logo of the independent curriculum, and the purpose of use. Front cover of student worksheet PBI Biology learning. The background of the cover is blue and green. The front cover of the student worksheet is as shown in Figure 4:

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Figure 4. Front cover of PBI worksheet

Worksheet designer and validator information

In this section displays information on student worksheet designers and student worksheet Validators that will be used in the learning process. The display of information on the PBI student worksheet designer can be seen in Figure 5 below:

Figure 5. Worksheet Designer Information

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Concept Map

The Concept Map contains a collection of materials that will be discussed in the PBI-based student worksheet, as an initial overview of the material to be studied is intended to make it easier for students and teachers to use it during the learning process. The appearance can be observed in Figure 6.

Figure 6. Concept Map

Figure 7. Learning Outcome and Objective

Learning Outcomes and Objectives

Learning Outcome and Learning Objective contain the learning outcomes and objectives in PBI-based student worksheet, as an initial overview of the material to be studied is intended to make it easier for students and teachers to use it during the learning process. The appearance can be observed in Figure 7.

Material

The material is a core part of the PBI-based student worksheet, where students can learn it by using the student worksheet. The material is structured and accompanied by a number of practice questions so that students can practice. The PBI-based student worksheet material on environmental change material as shown in Figure 8.

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Figure 8. Environmental change material

Exercise

Each sub-material is equipped with exercises for students to practice. This exercise is given so that students are able to find out the level of students' understanding of the material that has been taught. The appearance of the exercise can be observed in figure 9.

Figure 9. Exercise

Validation

The research and development of PBI-based student worksheet to improve the science literacy skills of high school class X students has been validated by validators. Validation was

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carried out by four experts, each consisting of two content/material experts, one media expert, and one linguist. The validation aims to assess the feasibility of the developed PBI-based student worksheet, reviewed from four main aspects: content/material, construction, language, and appearance. Each validator provides an assessment using *a Likert Scale* of 1–5. The validation data was analyzed in a quantitative descriptive manner by calculating the average score and interpreting it into the eligibility category. Here are the results of validation from experts:

Table 9. Recapitulation of student worksheet Validation Results by Experts

No.	Aspects Assessed	Average Score	Category
1	Content/Material Qualification (Members 1 & 2)	4,6	Highly Worth It
2	Student worksheet Construction (Media Expert)	4,5	Highly Worth It
3	Linguistics (linguists)	4,4	Highly Worth It
4	Display (Media Expert)	4,7	Highly Worth It
Average Overall Total		**4,55**	**Highly Worth It**

Based on the results of the analysis, a total average score of 4.55 was obtained, which is included in the category of "Very Feasible" (range 4.20–5.00). This shows that the student worksheet developed has met the feasibility criteria in terms of material substance, integration of the PBI approach, presentation structure, language, and visual appearance.

These findings are consistent with previous studies such as Amaliyah *et al.*, (2022) and *Öztürk et al.*, (2021) which emphasizes that student worksheet that are designed to be problem-based and tailored to the characteristics of students are able to meet high validity aspects when developed systematically and based on learning theory. The experts also gave positive notes regarding the consistency of the PBI stages used in the student worksheet, such as problem orientation, investigation, solution analysis, and reflection, which are important to build students' science literacy skills gradually and meaningfully.

Implementation stage

After passing the expert validation stage, the student worksheet based on *Problem-Based Instruction* developed was then implemented through a limited trial on class X students of SMA Negeri 5 Sungai Penuh City. This trial aims to assess the initial practicality and effectiveness of the product in the context of real learning. The trial activity will be carried out in May 2025 for two meetings, each lasting 2 × 45 minutes, on the topic of environmental change.

Implementation is carried out directly by biology teachers, while researchers act as observers. In this process, students use student worksheet as a learning guide that directs them to

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identify environmental problems, seek information, discuss, formulate solutions, and reflect on findings. Learning activities are facilitated through scenarios that are in accordance with the stages of PBI, starting from problem orientation, clarification of concepts, to final reflection.

Practicality data was obtained through a response questionnaire from 20 students and 1 biology teacher, who assessed the aspects of ease of use, clarity of instructions, flow of activities, and interest in the content of the student worksheet. The results of the recapitulation showed that the average student practicality score was 87.5% and the teacher was 92%, both in the "Very Practical" category. For more details, you can see the measured graph.

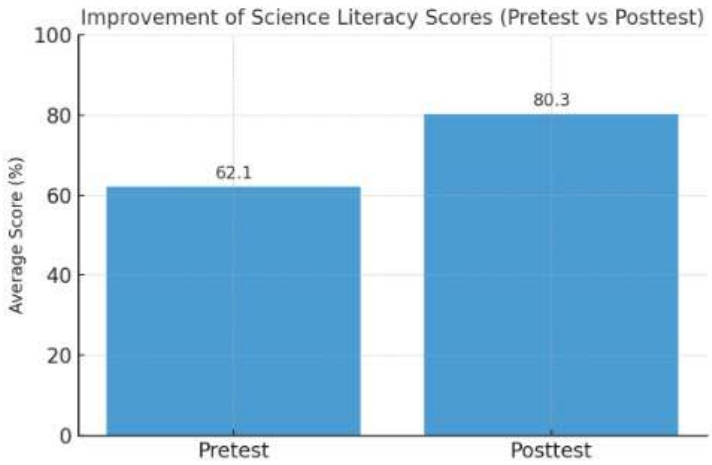

Figure 10. Increase in students' average science literacy scores between pretest and posttest

The improvement of students' science literacy skills after the use of student worksheet based on Problem-Based Instruction (PBI) can also be seen visually through the graph in Figure 8. The graph shows an increase in the average score from 62.1 during the pretest to 80.3 during the posttest. This increase shows that after participating in learning using PBI-based student worksheet, students experience an increase in their understanding of science concepts, as well as their ability to interpret, analyze, and relate scientific information to the context of daily life. This increase corroborates the initial effectiveness findings of the product that has previously been calculated using N-Gain, where the value of 0.48 is included in the medium category and shows a positive impact of the use of student worksheet on students' science literacy.

DISCUSSION

The results showed that the development of Problem-Based Instruction (PBI)-based Student Worksheets on environmental change materials had a high level of eligibility, with an

average validation score of 4.55 and a "very feasible" category. These findings show that the student worksheet developed is in accordance with pedagogical principles, especially in supporting the achievement of students' science literacy through an active and contextual learning approach (Zahra et al., 2022). These results are in line with research by Ain *et al.*, (2020) which shows that Worksheets developed based on an inquiry and problem-based approach are able to significantly improve students' science literacy skills. In an international context, also found that PBI can improve students' conceptual and critical thinking abilities simultaneously in science learning.

The practicality of the student worksheet obtained from the results of the limited trial also showed very high scores, both from teachers (92%) and students (87.5%), which indicated that the student worksheet was easy to use, understand, and in accordance with learning needs. This is reinforced by research by Wijayanti *et al.*, (2021) that problem-based learning media has a high level of readability and acceptance among students and biology teachers, especially in ecological learning (Puneeri *et al.*, 2022)

In terms of effectiveness, the increase in science literacy scores from pretest to posttest (from 62.1 to 80.3) and the N-Gain value of 0.48 (medium category), showed that the use of PBI-based student worksheet had a positive impact on improving students' science literacy. This improvement demonstrates success in developing students' skills to interpret scientific information, evaluate arguments, as well as relate scientific knowledge to everyday life phenomena. These results are in line with studies by Ramadhan *et al.*, (2023), which shows that the use of PBI in biology learning is able to improve conceptual understanding, science literacy, and learning outcomes simultaneously (Sholahuddin *et al.*, 2023; Suradi *et al.*, 2023) Similarly, research by Amaliyah *et al*, (2022) asserts that the PBI approach encourages students to ask reflective questions, build arguments, and interpret scientific data independently.

Furthermore, the development of this student worksheet is in line with the Independent Curriculum policy which emphasizes project- and problem-based learning as a means to form a Pancasila Student Profile. In the dimension of critical thinking and scientific reasoning, teaching tools such as PBI-based student worksheet can function as a concrete tool to bridge 21st century skills with curriculum learning outcomes. As emphasized in the Independent Curriculum guide Kemendikbudristek., (2022), teaching tools that carry out the exploration of real problems and reflective thinking are highly recommended to be used in learning at the high school level.

Thus, this study empirically proves that the development of PBI-based student worksheet is not only feasible and practical, but also effective in supporting the improvement of students' science literacy. These results contribute to strengthening the practice of developing learning media based on constructivism theory and contextual learning. However, the product trial in this study is still limited both in terms of time and number of students. Therefore, it is recommended that follow-up research be carried out with large-scale implementation tests, as well as advanced analysis that includes aspects of critical, collaborative, and creative thinking in an integrated manner.

CONCLUSION

This research produced a Problem-Based Instruction (PBI) based Student Worksheet which was systematically developed to improve the science literacy skills of high school grade X students on environmental change materials. The results of validation by experts show that student worksheet is classified as very feasible, both in terms of content, language, construction, and appearance. Limited trials showed that the student worksheet was very practical to use in learning, as well as having a positive impact on improving students' science literacy, as shown by the increase in posttest scores and N-Gain scores in the medium category. Thus, the PBI-based student worksheet developed is suitable for use as an alternative contextual teaching tool to support the implementation of the Independent Curriculum and improve the quality of science literacy at the secondary education level.

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