



# Development of Problem-Based Learning LKPD Based Local Potential of Baros Mangroves in Biology Subjects Environmental Pollution Material

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**Abstract:** This research aims to Producing learning media the PBL modeled LKPD based on the local potential of Mangrove Baros on environmental pollution material is suitable, practical and effective in enhancing the problem-solving abilities and environmental care attitudes of students in class X at SMAN 1 Kretek, Bantul, Yogyakarta. This research follows a research and development approach using the Four-D (4D) model, which consists of four stages: Define, Design, Develop, and Disseminate. Field trials of the LKPD PBL based on the local mangrove potential in Baros for environmental pollution materials were conducted through quasi-experimental research with a pretest-posttest control group design. The subjects of the field trial were 60 students from two classes. Data collection involved problem-solving ability test questions and questionnaires on environmental care attitudes. Data analysis was performed using the MANOVA test to analyze differences in students' problem-solving abilities and environmental care attitudes. The results of the MANOVA test indicated differences in the use of PBL modeled LKPD based on the local mangrove potential in Baros for environmental pollution materials concerning problem-solving abilities and environmental care attitudes.

**Keywords:** Environmental care attitude; Environmental pollution; LKPD; Problem-based learning (PBL); Problem solving ability

## Introduction

Indonesia is one of the countries with the largest mangrove forest area in the world. Based on data from the Ministry of Environment and Forestry in 2021, the area of mangrove forests in Indonesia reached 3.4 million hectares or around 24% of the total area of mangrove forests in the world (Solikhah, 2021). However, the area of mangrove forests in Indonesia continues to decline and is recorded as 637,624 hectares (18.95%) in critical condition due to canopy closure of less than 60% (Solikhah, 2021).

Currently, mangrove forests in Indonesia are experiencing a decline in function and facing damage both in terms of quality and quantity, so more serious conservation efforts need to be made. One example of a mangrove forest conservation area in Indonesia is the

Baros Mangrove Forest Conservation, which is located in Baros Hamlet, Tirtohargo Village, Kretek District, Bantul Regency, Yogyakarta. This area is very important in maintaining the sustainability of the mangrove ecosystem in Indonesia.

The Baros Mangrove Forest which is located in Baros Hamlet, Tirtohargo Village, Kretek District, Bantul Regency, Yogyakarta is a local potential that attracts with its natural beauty. This area is located on the southern coast of Java Island, providing a unique picture of the balance between sea and land. This mangrove forest offers a rich geographical background with a diverse ecosystem, which plays an important role in preserving the surrounding environment. Its existence not only provides natural beauty, but also supports the life of marine animals, and acts as an effective natural protector in reducing the negative impacts of coastal

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erosion. The Baros Mangrove Forest is a valuable asset that is well-maintained and developed as a sustainable ecotourism and environmental education destination (Rahmadhani et al., 2021).

In efforts to develop mangrove ecotourism on Baros Beach, community empowerment is also important. The mangrove eco-tourism program has been carried out to empower the Tirtohargo community with the aim of the conservation of coastal parks in Bantul. This program involves human resource training, provision of tarpaulin ponds, planting mangroves, and procurement of solar panels. Through this program, it is hoped that the community can be actively involved in mangrove conservation and improve their welfare (Wijayanti et al., 2019).

The results of an interview on April 4 2023 with a mangrove forest officer at Baros Beach showed that an environmental officer who worked in an area was affected by the problem of waste originating from the river and flowing into the mangrove forest. The officer painted a very worrying picture of the situation. Mangrove officials said that most of the waste that pollutes mangrove forests comes from human activities, including industry, settlements, and fishing activities around rivers. The most common types of waste include plastic, styrofoam, plastic bottles, sandals, and other household waste. Mangrove forests have an important role in maintaining the sustainability of coastal ecosystems. However, this rubbish has damaged the ecosystem. This rubbish accumulates between the roots of mangrove trees and prevents the growth of newly planted mangrove seedlings. As a result, many mangrove seedlings die due to a lack of access to sunlight and necessary nutrients. On the other hand, plastic waste also hurts marine biota around mangrove forests. Plastic can break down into small particles that enter aquatic ecosystems, disrupting marine ecology and posing a threat to fish and other animals. Apart from that, rubbish such as plastic bottles and styrofoam can become a trap for marine animals, such as crabs, which can get trapped in it. The interview results also emphasize the importance of environmental education to change human behavior regarding waste management. Public awareness about the negative impact of waste on the environment needs to be increased, especially for the next generation, namely students who must be instilled with love for the environment from an early age.

Integration of the local potential of the Baros Mangrove Forest in Biology learning involves the use of biodiversity and coastal ecosystems as study objects. Students can learn about mangrove types, identify their morphological characteristics, and understand the interactions of organisms in the mangrove ecosystem

(Fahmi et al., 2021). Learning also includes research on the ecological benefits of mangrove forests, such as their role in controlling sea water intrusion, reducing coastal erosion, and increasing fisheries productivity (Utomo et al., 2018). This integration also involves local communities in the management and preservation of mangrove forests, including rehabilitation activities, managerial and technical training, as well as outreach about the importance of protecting mangrove forests (Iswahyudi et al., 2019; Koneri & Maabuat, 2021). With the active participation of local communities, Biology learning can highlight the importance of community involvement in preserving mangrove forests and sustainable management of natural resources (Hasnanda et al., 2021).

Environmental pollution material has significant relevance in understanding environmental problems by society, especially by students. Several studies show that learning principles that are more environmentally oriented as a learning resource are very important to pay attention to in achieving learning success (Setiawan & Mulyati, 2020). The environment also makes the largest contribution to a person's health status compared to other factors such as behavior, health services, and heredity (Novita, 2020). Apart from that, the human nature of never being separated from the environment is also the reason for the need to learn about environmental pollution, including disasters that have occurred (Listyaputri & Patridina, 2022). In the context of climate change, understanding climate change and its impact on health, the economy and other aspects of life is very important for students (Yuliantoro, 2019).

Learning process activities require facilities to help and facilitate teaching and learning activities so that effective interaction is formed between students and educators, one of which is using student worksheets (LKPD). The results of interviews with biology teachers at SMAN 1 Kretek Bantul School, Yogyakarta, revealed that they tend to use student packet books and teacher guidebooks as the main sources in the learning process. This has resulted in the use of Student Worksheets (LKPD), which should be a valuable learning aid, not reaching its maximum potential. One factor that is an obstacle is the limited time these teachers have because they have to teach in various classes from class X to XII. This time limitation certainly affects their ability to prepare additional learning materials such as LKPD.

Student Worksheets (LKPD) based on Problem Based Learning (PBL) in Biology learning is an effective learning model for increasing student involvement and understanding. PBL is a learning model that places students as active learners and provides relevant problems that will be solved using students' knowledge and other sources (Rachmawati et al., 2022). In PBL,

students will be involved in thinking and understanding the material in groups by carrying out investigations and inquiries into real problems around them (Rachmawati et al., 2022).

Apart from that, the problem-solving abilities of students at this school are still low. This can be seen from the results of student's assignment scores on environmental pollution material, which only reached 65% and was below Minimum Completeness (KKM). From these results, it can be concluded that students' abilities in solving environmental-related problems still need to be improved. It was also found that in the learning process, environmental issues, such as those related to mangrove forests, had not been raised as part of classroom learning. As a result, one of the important attitudes in protecting the environment, namely awareness of the environment around the school, appears to be less developed. This is reflected in the condition of the school environment which is less clean, including classrooms, toilets, school grounds, and other areas when observations are made. There needs to be improvements in learning approaches that consider environmental problems and encourage students to be more concerned and responsible for the environment around the school. In line with Rokhmah et al. (2021) who stated that through biology learning which involves problem-solving and developing an attitude of caring for the environment, students can understand the importance of protecting the environment and have the initiative to prevent environmental damage.

On the other hand, the biology teacher at SMAN 1 Kretek Bantul Yogyakarta School also revealed that the use of the PBL (Problem-Based Learning) learning model is still rarely applied in the learning process. More often, conventional learning methods are still the main choice in teaching. This condition shows that the potential that can be taken from the PBL model in improving students' interactions, conceptual understanding, and problem-solving abilities has not been fully maximized. Therefore, further efforts need to be made to promote and implement the PBL learning model so that it can provide greater benefits in the learning process in the school. The Problem-Based Learning (PBL) learning model is an active learning model and allows students to learn through problem-solving. PBL involves students actively in solving problems presented during the learning process. In PBL, students are given an authentic and complex problem that requires solving through critical thinking, collaboration, and independent research.

The development of the PBL (Problem-Based Learning) LKPD (Learner Worksheet) based on the local potential of the Baros Mangrove Forest is to provide a meaningful and relevant learning experience for

students. Through the PBL model, students will be invited to face concrete problems related to their environment, such as the environmental problems faced by the Baros Mangrove Forest. In this way, they can develop a deeper understanding of the mangrove ecosystem and its environment. Apart from that, integration with the local potential of the Baros Mangrove Forest also aims to foster a sense of love and responsibility for the local environment, as well as provide opportunities to actively participate in the preservation and protection of the important mangrove ecosystem. In this way, it is hoped that this LKPD can stimulate students' interest and motivation in studying Biology while developing awareness of the importance of preserving the natural resources around them. Therefore, researchers developed learning media in the form of Biology LKPD which uses the syntax of PBL model learning activities as an alternative learning media that is suitable for improving students' problem-solving abilities and environmental care attitudes.

**Method**

This research was conducted at SMA Negeri 1 Kretek Yogyakarta for 3 weeks in May in class X MIPA. This research aims to produce a PBL-based biological LKPD product integrated with the local potential of the Baros mangrove forest for class X MIPA. This research uses the Research and Development (R&D) method. The R&D method is a research and literature study method to produce certain product designs and develop them by testing the validity of the design so that it becomes a product that has been tested and can be widely used (Sugiyono, 2020).

The research subjects for the development of PBL LKPD based on the local potential of Baros mangroves regarding environmental pollution were 30 students of class X MIPA SMA Negeri 1 Kretek Yogyakarta. The expert validation questionnaire assessment and student response results will be analyzed based on the questionnaire assessment criteria presented in the following table (Riduwan, 2012).

**Table 1.** Eligibility Criteria

Value (%)	Category
81-100	Excellent
61-80	Good
41-60	Enough
21-40	Not good
0-20	less than once

**Results and Discussion**

The data produced in this research is the result of the feasibility and practicality of LKPD. Feasibility is

obtained from validation results by 2 validator experts, namely material experts and media experts. Practicality is obtained from teachers and student responses.

In the initial design stage, researchers prepared several components that would be included in the PBL Student Worksheet (LKPD) based on the local potential of mangroves in Baros. These design steps include preparing environmental pollution material, designing learning activity steps by the syntax of the Problem-Based Learning model, as well as creating a design for the LKPD. This research produces PBL-based LKPD on environmental pollution material which can be seen in Figure 1.

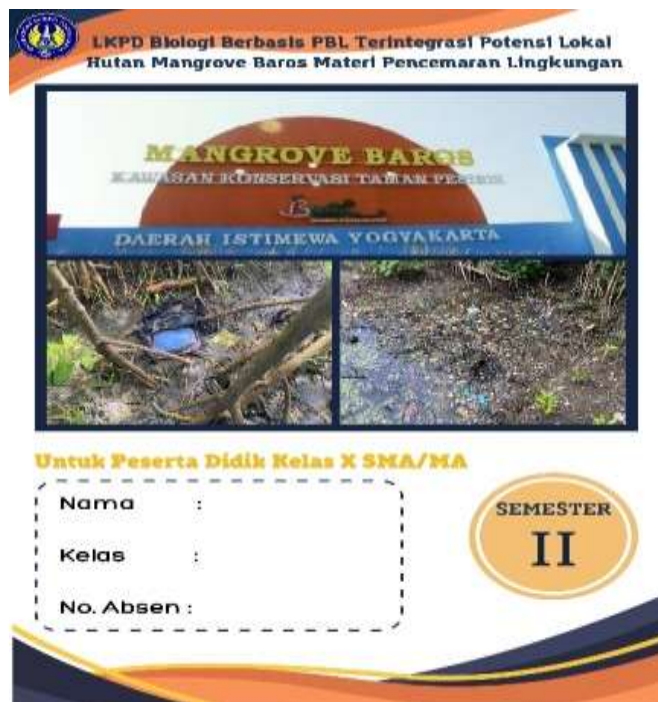


Figure 1. Home page of PBL-based LKPD

At this stage, the researchers carried out product development, namely producing PBL Student Worksheet (LKPD) learning media based on the local potential of mangroves in Baros. The product developed must pass the validation stage before it can be used. This validation aims to obtain input from biology experts and educators to ensure that the product that has been developed meets appropriate standards. After passing the validation stage, this product will be evaluated by experts and also assessed in terms of practicality of use by biology educators. In this way, products that have gone through a series of stages can be guaranteed to be of good quality and good to use.

Validation results were obtained through research by experts in the field of learning materials and media related to PBL Student Worksheets (LKPD) and combining elements of local potential from mangroves in Baros. Apart from that, a table containing a tabulation

of validation results by material experts and media experts can also be found in Table 2.

Table 2. Material Expert Validity Results

Assessment aspects	Average score	Results of each aspect	Criteria
Materials expert	3.2	80	Good
Quality language	4	100	Very good
Average		90	Very good

Based on Table 2, the LKPD PBL learning media based on the local potential of mangroves in Baros on environmental pollution material is included in the very good category, so this media can be said to be very valid and good to use. Material experts provided several inputs/suggestions, including; "(Many of the sentence structures/structures in the statement options are lacking/unclear. In terms of material, the substance of photos, images, and discourse only shows problematic environmental phenomena, and does not yet show the phenomenon of environmental change. Almost everything is like that. Suggestion, the title should be shifted not to the topic "Environmental Change", but rather "Environmental Pollution" whose analytical meaning is sufficient to be carried out through comparison with environmental quality standards according to its intended use only)." The assessments given by media experts can be seen in Table 3.

Table 3. Media Expert Validity Results

Assessment aspects	Average score	Results of each aspect	Criteria
Technical	3.14	78.5	Enough
Language	3	75	Very good
Construction	3.62	90.5	Very good
Average		81.3	Very good

Based on Table 3, the LKPD LKPD PBL learning media based on the local potential of mangroves in Baros on environmental pollution material is included in the very feasible category, so the media can be said to be very valid and suitable for use. Apart from that, data was also obtained based on assessments by biology educators in the form of questionnaires. In the media practicality questionnaire, five aspects were assessed, namely the appropriateness aspect of the material, the accuracy aspect of the material, the didactic aspect, the construction aspect, and the technical aspect. The results of the practicality assessment can be seen in Table 4.

Based on the data in Table 4, it can be seen that the PBL LKPD based on the local potential of mangroves in Baros on environmental pollution material shows very feasible results, so it can be concluded that the LKPD is practical for use in learning. The biology educator said that "LKPD PBL based on the local potential of

mangroves in Baros on environmental pollution material can encourage collaboration between biology educators, students, and local communities to maximize understanding of the local potential of mangrove forests in Baros and environmental pollution. "On the other hand, apart from ensuring understanding of the concept, try to also arouse students' interest in the environment and sustainability by linking it to the local potential of mangrove forests in Baros.

**Table 4.** Teacher Practicality Test Results

Assessment aspects	Average score	Results of each aspect	Criteria
Material feasibility aspects	3	75	Good
Aspects of Material Accuracy	2.6	65	Good
Didactic aspect	3	75	Good
Construction aspects	3.3	82.5	Very good
Technical aspects	3.25	81.25	Very good
Average		75	Good

After that, a limited trial was carried out by students to determine the readability of LKPD PBL learning media based on the local potential of mangroves in Baros on environmental pollution material based on student response questionnaires. The number of students who took part in the trial was limited to 30. There are four aspects contained in the media readability questionnaire, namely technical aspects, visual appearance aspects, media aspects, and content aspects of learning material. The results of student responses can be seen in Table 5.

**Table 5.** Results of Student Response Questionnaire

Assessment aspects	Average score	Results of each aspect	Criteria
Technical aspects	3.24	81	Very good
Visual display aspects	3.23	80.75	Good
Media aspect	3.3	82.5	Very good
Aspects of Learning Material Content	3.38	84.5	Very good
Average		82.1	Very good

Based on data from Table 5, it can be concluded that the LKPD PBL based on the local potential of mangroves in Baros on environmental pollution material has produced very feasible results. Therefore, the LKPD is practically used in learning. Students expressed that "attractive media displays and learning activities using these media are very helpful in increasing our understanding of the local potential of mangrove forests in Baros. This indirectly makes us more aware of the importance of taking good care of the environment."

The development of PBL LKPD based on the local potential of mangroves in Baros on environmental

pollution material needs to be validated by media experts and material experts to ensure the suitability of the product (Amthari et al., 2021). Validation is carried out to evaluate the quality and effectiveness of LKPD in improving student learning outcomes. The feasibility of a PBL LKPD based on the local potential of mangroves in Baros regarding environmental pollution is very important. To ensure that the LKPD meets high-quality standards, the validation process must be carried out first by two competent expert lecturers. This validation is carried out to evaluate the substance of the media and materials before the LKPD is used for trials. In the validation process, three aspects are assessed related to media, namely technical, language, and construction aspects. The score results from the two validators show that the average score for each aspect is 81.3, in the very feasible category. This indicates that the media used in this LKPD meets high-quality standards and can be relied upon to support learning.

Furthermore, the aspects assessed related to the material involve assessing the quality of the material and the quality of the language used in the LKPD. The score results from the two validators show that the average score for each aspect is 90, with a very decent category. This confirms that the material presented in the LKPD is of very good quality, and the language used also meets high standards. Thus, based on the results of validation carried out by two expert lecturers, the PBL LKPD based on the local potential of mangroves in Baros on environmental pollution material has very good quality in terms of media and material. Therefore, this LKPD is declared suitable for use in the learning process and is expected to make a positive contribution to increasing students' understanding of environmental pollution by utilizing the local potential of mangrove forests in Baros. On the other hand, in line with research by Fajarianingtyas et al. (2020) shows that PBL LKPD based on the local potential of mangroves in Baros on environmental pollution material can improve process skills and student learning outcomes. The results of material and media expert validation of the PBL-based practicum module show high validity.

Apart from that, based on assessments by biology educators on the media practicality questionnaire on environmental pollution material, the average was 85 with a very appropriate rating category. So it can be concluded that the LKPD is practical for use in learning. The biology educator said that "LKPD PBL based on the local potential of mangroves in Baros on environmental pollution material can encourage collaboration between biology educators, students, and local communities to maximize understanding of the local potential of mangrove forests in Baros and environmental pollution. "On the other hand, apart from ensuring understanding

of the concept, try to also arouse students' interest in the environment and sustainability by linking it to the local potential of mangrove forests in Baros."

Apart from that, product trials also need to be carried out involving students as respondents (Ihsan et al., 2022). This trial aims to collect input and feedback from students regarding the use of LKPD in learning. The readability of the LKPD PBL learning media based on the local potential of mangroves in Baros on environmental pollution material was assessed through a response questionnaire from 30 students. This questionnaire covers four important aspects, namely technical aspects, visual appearance aspects, media aspects, and learning material content aspects.

The results of the analysis of student response data show that the average score for each aspect reached 82.1, with categories showing very good readability. This means that the PBL LKPD based on the local potential of mangroves in Baros has succeeded in creating learning material that is very easy for students to understand.

Thus, it can be concluded that this LKPD has provided very satisfactory results to increase students' understanding of environmental pollution material. This success indicates that the LKPD is a practical learning tool and can be easily used in the classroom learning process. This will help increase the effectiveness of biology learning with a PBL approach based on the local environment. Thus, this approach should be considered for application in further learning contexts.

Students expressed that "attractive media displays and learning activities using these media are very helpful in increasing our understanding of the local potential of mangrove forests in Baros. This indirectly makes us more aware of the importance of taking good care of the environment." In the context of developing LKPD, it is important to pay attention to the validity and readability of the instruments used. This is in line with research conducted by Triyoso et al. (2017) shows that competency-based comprehensive assessment instruments in biology subjects have good validity and readability (Triyoso et al., 2017).

## Conclusion

Based on the results of research regarding the development of PBL LKPD based on the local potential of mangroves in Baros on environmental pollution material at school. Based on the results of the MANOVA analysis, the value was 0.637 and it can be concluded that the value is significant ( $p < 0.05$ ). Therefore,  $H_0$  is rejected and  $H_a$  is accepted. Thus, it can be stated that there are differences in problem-solving abilities and environmental care attitudes between students who

took part in learning using the local potential-based PBL LKPD Baros Mangrove on environmental pollution material carried out at SMAN 1 Kretek Bantul School, Yogyakarta, and students who took part in learning using LKPD with a conventional learning model without integration with the local potential of mangrove forests in Baros on environmental pollution material.

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## Conflicts of Interest

The authors declare no conflict of interest.

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