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Development of Problem-Based Learning (PBL)-Based Student Worksheets on Environmental Pollution

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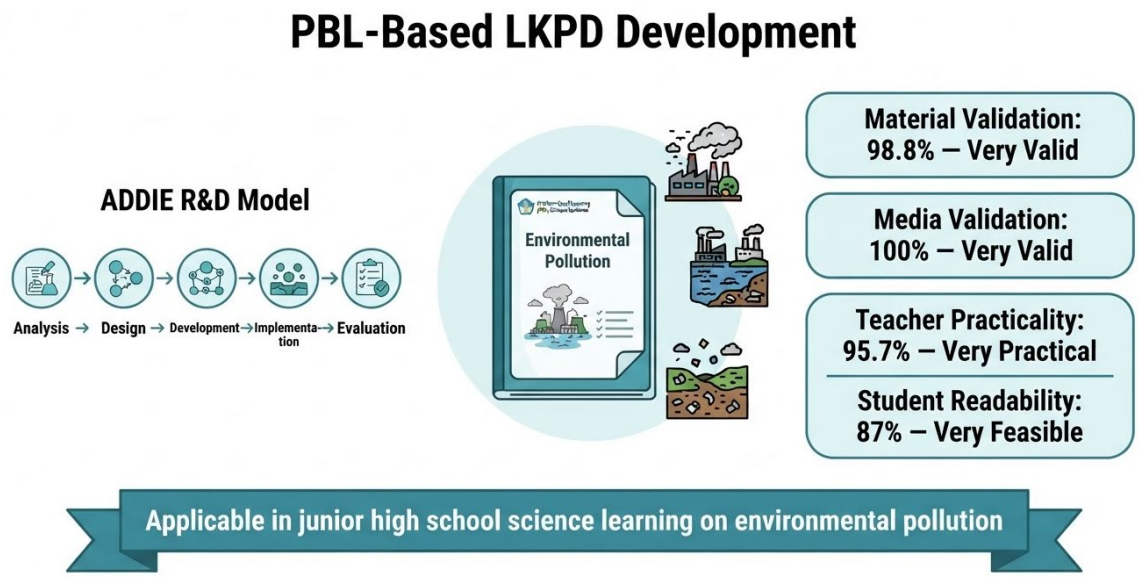
Abstract: This research aims to produce Student Worksheets (LKPD) based on Problem-Based Learning (PBL) using valid and appropriate environmental pollution materials. This research is included in Research and Development (R&D) with the ADDIE model, namely Analysis, Design, Development, Implementation, and Evaluation. This study obtained both quantitative and qualitative data. Quantitative data were obtained from media validation results, material validation results, practicality assessment scores, and LKPD readability scores. Qualitative data were obtained from interviews with educators, relevant literature studies, and suggestions and comments from validators, educators, and students. The results of material and media validation by the validator obtained average scores of 98.8% and 100%, which are included in the very valid category. The results of the practicality test by educators obtained an average score of 95.7%, which is included in the very practical category. Meanwhile, the results of the media readability test by students obtained an average score of 87%, which was included in the very feasible category. Based on the results of this study, it can be stated that PBL-based LKPD media can be implemented in science learning at the junior high school level regarding environmental pollution.

Keywords: Student Worksheet, Problem-Based Learning, Environmental Pollution, junior high school students

Graphical Abstract



INTRODUCTION

Science is the discipline that studies the laws, concepts, and facts regarding natural phenomena whose validity has been verified through investigation and research. Science education has various characteristics that can be examined from multiple perspectives: it is a continuous process, much like scientists' work in discovering scientific knowledge, and it is also the product of scientists' work (Tala & Vesterinen, 2015). Through science, students can develop critical thinking skills, learn to investigate and solve problems, and acquire knowledge related to technology and society. Science education helps students understand scientific knowledge and the laws of nature through process skills, enabling them to master this knowledge and apply it in their daily lives. In the era of the Fourth Industrial Revolution, students are expected to become an outstanding, innovative, productive, and creative generation (Wicaksono, 2020).

Science education has several characteristics (Silk et al., 2009). Most educators transfer knowledge to students regarding concepts, theories, laws, and facts about natural phenomena without giving students the opportunity to acquire and construct scientific concepts independently (Silk et al., 2009). The method used in science instruction is lecturing. This results in students playing only a passive role in receiving knowledge (Silk et al., 2009). Findings from observations conducted by Ruslaini et al. (2017) indicate that, during the learning process, students' opportunities to generate ideas are not maximised because educators play an overly dominant role.

Another characteristic of science learning is that it involves following the scientific method to discover knowledge; in this process, students play an active role in seeking, discovering, and processing the knowledge they acquire on their own. Students are trained to recognise facts, identify differences and similarities among them, and investigate relationships between them, enabling them to construct their own

knowledge. Students can apply scientific knowledge and make decisions more easily because they understand how to acquire it (Tala & Vesterinen, 2015).

When teaching material on environmental pollution, real-world objects found in the surrounding environment are needed as learning resources; thus, students are required to be actively engaged and use their surroundings to understand concepts and identify various types of pollution occurring in the environment (Fitriani, 2019). Environmental topics are among the most important issues capturing public attention today. This is because environmental quality has declined almost worldwide, making it necessary to instil awareness of the environment's role in sustaining life through learning activities that can enhance critical thinking skills regarding environmental issues and foster a sense of love and care for the environment (Kurniawan et al., 2015).

Many factors limit educators in conducting teaching and learning activities on environmental pollution. Interviews conducted with science educators at SMPN 17 Surabaya revealed that they face difficulties in teaching students about environmental pollution. Educators cannot directly demonstrate real-world examples of environmental pollution. Students are not sufficiently supported in their learning activities because no Student Worksheets (LKPD) are available. The learning process for environmental pollution topics lacks direction because students do not have access to LKPDs. Students are also not yet active enough in science classes; therefore, interactive LKPDs are needed to support the learning process. Consequently, interactive LKPDs need to be developed using the LiveWorksheet platform.

LKPDs are useful learning tools that support the learning process. LKPDs are designed to facilitate educators' teaching and learning activities. LKPDs are used to foster students' independence and understanding as they complete assignments. Using LKPDs gives students opportunities to be active, creative, and critical during the learning process. In addition, implementing LKPDs supports the achievement of indicators and competencies aligned with the curriculum and helps achieve learning objectives (Apertha et al., 2018). Knowledge gained through actively exploring the surroundings and the experiences acquired through learning will be more deeply ingrained in students (Djamaluddin & Wardana, 2019).

Changing times and current natural phenomena have changed many fields, including education. In education, learning activities were initially conducted in schools but have since shifted to virtual settings at students' homes or other locations. This at-home learning can be referred to as online learning (Hazlita, 2021). Learning activities can now take place anywhere, so assessments and similar activities can be conducted online. However, delivering instructional material online has proven less effective because learning resources are not being used to their full potential. Students easily become bored during online learning activities (Putria et al., 2020). Several products have been developed to support online-based learning, including CTL-based e-modules (Marsuki et al., 2021) and E-LKPDs on intermolecular forces (Agustina et al., 2021).

Educators are expected to continually innovate in the learning process to enhance students' understanding of science curriculum content. The implementation of learning activities can be supported by various applications and websites, one of which

is LiveWorksheet. This website can be accessed via the link www.liveworksheets.com by anyone without the need to register. Educators who wish to create assignments using LiveWorksheet must first create an account to use the platform. One advantage of this website is the wide variety of question types available, including checkboxes, essay questions, multiple-choice questions, drag-and-drop, and more. In addition, educators can utilise questions created by other LiveWorksheet users by sending students the assignment link. Once students complete the questions, their scores appear automatically.

A study conducted by Hazlita (2021) examined the implementation of online learning using LiveWorksheet for lessons on similarity and congruence. The study found a difference in participant engagement between online learning using conventional methods (48.44%) and online learning using LiveWorksheet (74.29%), indicating that using LiveWorksheet in online learning can increase participant engagement in learning activities. A similar study was conducted by Rhosyida et al.(2021), which found that LiveWorksheets can be an effective component of learning, particularly as an interactive, engaging online assessment tool that offers a variety of easily accessible activities tailored to students' characteristics. Activity formats can be varied according to students' needs, and tasks can be assigned individually or in groups. Sulisworo & Ariskasari (2021) also conducted similar research on an innovative learning medium, namely LiveWorksheet. LiveWorksheet is interactive and engaging for students. Using LiveWorksheet as a learning tool makes students more enthusiastic and active in the learning process and in completing assignments given by educators.

Scientific attitudes in science education include critical thinking, curiosity, creativity, honesty, and so on. Students are supported in applying constructivist theory through the Problem-Based Learning (PBL) model to develop the character of a scientist. In implementing the PBL model, students are trained to investigate problems relevant to everyday life. The PBL model is designed to improve learning quality by focusing students on mastering the material presented. The problems addressed in this model are authentic, novel, and relevant to the surrounding environment or context (Abdillah & Astuti, 2021).

Aligned with current educational trends, the PBL model is a student-centred approach that places students at the centre of the learning process. Student-centred learning provides students with opportunities to explore and develop their problem-solving skills. Implementing the PBL model helps develop students' active problem-solving skills (Abdillah & Astuti, 2021). PBL uses real-world problems as a context for students to improve their problem-solving skills and gain essential knowledge and concepts from the science curriculum. Environmental pollution is particularly well-suited to the PBL model, as it bridges theory and real-world phenomena and helps students develop problem-solving skills (Lestari, 2019).

Students are expected to solve problems related to environmental pollution and understand its dangers and impacts through PBL-based scientific activities presented as worksheets. According to the Human Resources Development Agency (BPSDM), the PBL model can develop students' critical thinking skills by helping them discover concepts and solve problems related to daily life (Bahriah, 2015). Students are

expected to solve the given problems by independently applying the knowledge they have acquired. The objective of this development research is to produce valid and appropriate Problem-Based Learning (PBL) based Student Worksheets (LKPD) on the topic of environmental pollution. The research results are expected to yield PBL-based LKPDs that can be implemented in junior high school science classes.

METHOD

The research type used to develop PBL-based student worksheets on environmental pollution is research and development (R&D). The product development model used is the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it provides a coherent and systematic framework for organising a series of development activities and design research. The ADDIE framework consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model development procedure is illustrated in Figure 1 (Tegeh et al., 2014).

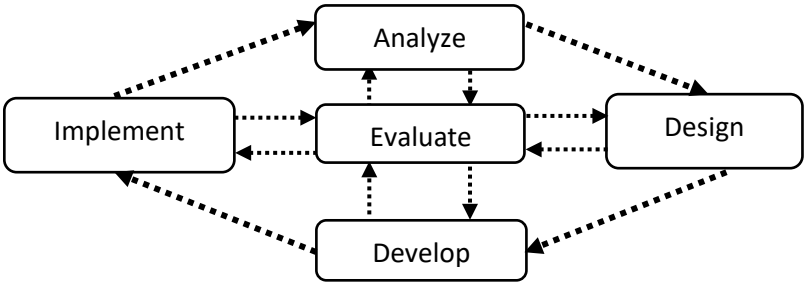


Figure 1. ADDIE Framework

The analysis phase involved conducting a needs analysis to identify the needs and problems faced by the research subjects. This phase involved interviewing two science teachers at SMPN 17 Surabaya to determine students' characteristics, which were then analysed. In addition to the students' characteristics, the school's needs to support learning quality were also analysed, including the need for worksheets. This was done to determine which worksheets needed to be developed to support the teaching and learning process. A literature review was also conducted to enhance the quality of the developed worksheets.

The design phase involved selecting a scheme or design aligned with the objectives of developing PBL-based worksheets. This was adapted to the conditions identified in the analysis phase to address any existing shortcomings. During this phase, the conceptual design of the PBL-based worksheets was developed by gathering various materials and information related to the worksheets. Students can complete the worksheets via the Liveworksheet website. Creating the LKPDs involved several steps, beginning with determining the topic or material to be used, followed by designing the LKPD content in accordance with the learning model specified in this study, which applied the PBL learning model. The LKPDs were then designed, starting with the cover page and continuing through the LKPD content. During this phase, various editing applications were used, including Microsoft Word, Photoshop, and Canva. For this study, Canva was

selected for editing. The next step was to upload the edited content to the LiveWorksheet application and configure it according to the product's intended purpose.

The development stage involves creating the LKPD according to the predetermined design. The completed product is then validated by a validator, a faculty member from the Science Education program at Malang State University. This validation is conducted to obtain suggestions for improving the LKPD so that the final product is valid. This validation is conducted using a pre-established instrument. The content validation evaluated conceptual accuracy, content appropriateness, presentation appropriateness, and language appropriateness. In the media validation, the software and visual elements were evaluated. In addition, the practicality of the products was tested by practitioners, specifically two junior high school science educators and their readability was assessed by 60 eighth-grade students. The educator response questionnaire evaluated content appropriateness, presentation appropriateness, content relevance, efficiency, and language appropriateness; the student questionnaire evaluated content appropriateness and presentation appropriateness.

The implementation phase involved pilot testing the PBL-based worksheets that had been developed with 60 eighth-grade students from classes VIII A and VIII D at SMPN 17 Surabaya, conducted in July 2022. Students were asked to complete the developed worksheets using their own devices. The worksheets were completed according to the instructions found on the first page. After completing the worksheets, students were given a student response questionnaire to assess whether the worksheets met their needs. The Evaluation stage aims to identify the strengths and weaknesses of the developed product. The evaluation aims to improve the product currently under development, namely the PBL-based worksheet on environmental pollution. The evaluation is based on various data that have been collected. The evaluation stage is conducted throughout the worksheet development process.

The study was conducted at SMPN 17 Surabaya from May to August 2022. The pilot study sample consisted of classes VIII A and VIII D, with 60 students and two science teachers. The students had completed their science lessons on environmental pollution, which was selected through purposive sampling. The test results were then analysed to determine the worksheets' suitability. This study yielded both quantitative and qualitative data. Quantitative data were obtained from validation scores provided by validators, namely university lecturers or experts, as well as practicality scores provided by junior high school science teachers, practitioners, and students. Qualitative data were obtained from interviews with teachers, relevant literature reviews, and suggestions and comments provided by validators, teachers, and students. These comments and suggestions served as a reference for revising the product.

Data collection in this study utilised a validation questionnaire from subject matter and media experts to determine the product’s level of validity. An interview guide was used to interview educators and understand the conditions at their schools. The practicality of the developed product was assessed through a response questionnaire regarding the LKDP, which was administered to both educators and students.

This study used the Likert and Guttman scales for data analysis. The Likert scale is used to measure the attitudes, opinions, and responses of an individual or group toward social phenomena specifically defined by the researcher (Soegiyono, 2013). The Likert scale aims to ensure that respondents answer the various questions presented in the questionnaire (Irawan Ihya' Ulumuddin & Sulistiyawati, 2021). The Likert scale was applied in this study to the material and media validation sheets as well as the response questionnaire. The Likert scale criteria for assessing the LKPD are as follows: a score of 1 falls into the "strongly disagree" category, a score of 2 into the "disagree" category, a score of 3 into the "agree" category, and a score of 4 into the "strongly agree" category (Priyono, 2018). According to Sutrisno (1991), the four-point scale was modified to eliminate the weaknesses of the five-point scale, namely ambiguity, a tendency toward middle-range responses, and the inability to clearly discern whether respondents lean toward "agree" or "disagree" (Sutrisno, 1991).

Researchers use the Guttman scale to measure conceptual validity. Studies employing the Guttman scale are conducted when researchers seek definitive answers to specific research questions. The Guttman scale uses only two intervals, namely "agree" or "disagree," which can also be replaced with "yes" and "no" (Soegiyono, 2013). The "Yes" response is coded as 1, and the "No" response is coded as 0 (Pranatawijaya & Priskila, 2019). The assessment results obtained from the validation and practicality tests were then calculated and converted into percentages (%P = percentage of the assessment score) using the following formula.

$$\%P = \frac{obtained\ score}{possible\ maximum\ score} \times 100\%$$

The resulting percentage is then compared with the validity and practicality criteria shown in Table 1 (Akbar, 2013). According to Akbar (2013) learning materials can be implemented if the readability and validity percentages exceed 70%.

Table 1. Validity and Practicality Criteria

No.	Achievement Level (%)	Validity Criteria	Practicality Criteria
1.	85.01%–100.0%	Highly valid	Highly practical
2.	70.01% - 85.00%	Valid	Practical
3.	50.01%–70.00%	Less valid	Less practical
4.	01.00% - 50.00%	Invalid	Not practical

RESULTS AND DISCUSSION

The development of these student worksheets was carried out through several stages, namely Analyse, Design, Develop, Implement, and Evaluate.

Analyse

This stage involved gathering data on student characteristics and aspects of the learning process that were not being adequately addressed in the classroom, particularly regarding the topic of environmental pollution. The analysis stage was conducted using interviews. Interviews with science teachers were conducted to

identify the challenges they faced in implementing classroom learning and to understand students' conditions and characteristics. The interview results indicated that science instruction was delivered through lectures and discussions. Environmental pollution was considered quite challenging. This was evidenced by the students' average score of 86, with the minimum passing score (KKM) set at 85. Instruction was delivered by having students visualise environmental conditions in their surroundings that were affected by pollution.

Educators face difficulties in the classroom when presenting environmental pollution phenomena that specifically point to a particular type of pollution. Educators stated that in addition to introducing environmental pollution in general, they also need to introduce more specific instances of environmental pollution. This statement was conveyed through the following interview excerpt: "In the teaching process on environmental pollution, I usually rely solely on the surrounding environment. However, this is not sufficient to provide examples of environmental pollution that focus on a specific type, such as water pollution."

Educators use a variety of strategies to address the learning difficulties students face. One strategy is to create various learning media to enhance students' understanding of the material presented. Educators commonly use PowerPoint as a teaching tool, while Google Forms and Quizizz can be used to distribute worksheets. Additionally, assignments are given through textbooks and other resources. The worksheets provided by educators are considered insufficient in facilitating students' learning activities. Students show greater interest in using electronic worksheets compared to conventional ones, as indicated in the following interview excerpt: "I've observed in class that students' interest in completing worksheets is higher when using electronic worksheets compared to conventional ones because they can be completed directly on their own devices." One type of worksheet available at that can facilitate students' learning activities is the "liveworksheet." However, educators have never used liveworksheets as a worksheet medium presented to students. This is stated in the following interview excerpt: "I don't know about liveworksheets and have never used them. I usually use Quizizz and Google Forms to assign tasks."

The ability to innovate in worksheet development is considered extremely important. Innovation is essential, given that teaching and learning activities evolve with the times. This is reflected in the following quote from an interview: "Innovation is essential in developing worksheets by making them more engaging with the help of various applications now available. Students can better understand the material because they receive visual representations of the content, not just the theory."

At this stage, a literature review of relevant research was also conducted to ensure that the developed worksheets are improved from previous versions and remain relevant to current conditions. Research conducted by (Fatmawati, 2016) explains that, based on the situational analysis, the development of learning materials on the concept of environmental pollution remains minimal. Students only use learning materials prepared by schools or publishers, such as worksheets and textbooks. A limitation of this study is the lengthy implementation period; therefore, educators are advised to carefully consider the available time allocation. A similar study on the application of

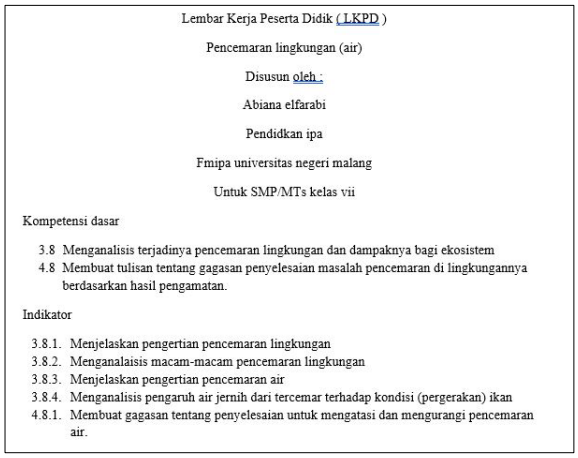
the PBL model using LiveWorksheet, conducted by (Andriyani et al., 2020) , showed that, in general, students lacked interest, perseverance, and did not attempt to seek information to solve the problems presented. Educators still rarely or not very often use liveworksheets. The results of the study indicate an increase in student engagement, as evidenced by their enthusiasm, independence, and self-confidence in completing worksheets. Additionally, a study conducted by (Suratini,2020)) aimed to determine whether the PBL learning model supported by worksheets could improve learning outcomes and activity in science education on the topic of environmental pollution. The study was conducted in response to students' lack of interest in learning activities, as the learning process still relied on the lecture method. The results indicated that the PBL learning model effectively improved learning outcomes and student engagement. Research related to the development of worksheets integrated with LiveWorksheet was also conducted by Widiyani & Pramudiani (2021). This study was motivated by boredom that arose from educators using learning media that were not interactive enough. However, some students still faced difficulties due to the lack of instructions on how to complete the tasks. Another study was also conducted (Hariyati & Rachmadyanti, 2022). Based on a needs analysis conducted at the school, it was found that educators had not yet developed engaging and innovative strategies. Educators relied on students' textbooks and several other references. During implementation, an unstable internet connection created obstacles and hindered the completion of worksheets.

The literature review indicates that implementing the PBL learning model can improve student learning outcomes and engagement. However, implementing the PBL model requires significant time because students conduct direct observations through laboratory experiments. Additionally, many educators are still unaware of or do not use the LiveWorksheet website as a platform for worksheets. Previous studies had limitations, such as not including instructions for completing the worksheets. Based on interview results with educators and the literature review, the researcher developed worksheets integrated with current articles on environmental pollution. This ensures that class time is maximised during the learning process, and students can actively discuss and observe the environmental pollution phenomena presented. The developed worksheets also include completion instructions, and the researcher has added materials integrated with Issuu, making the content provided to students more comprehensive.

Educators are required to innovate in line with the ever-evolving world of education. The importance of innovation is also highlighted by Hapsari & Fatimah (2021) in their article "The Role of Innovation in Learning", stating that through educational innovations implemented by educators, learning activities can proceed smoothly, actively, creatively, and in a conducive manner, thereby fostering a sense of enthusiasm for learning among students to achieve learning objectives and improve their academic performance (Hapsari & Fatimah, 2021).

Design

PBL-based worksheets were designed using Microsoft Word, Canva, and LiveWorksheet. The worksheets were developed using material on environmental pollution, specifically water pollution. Water pollution was chosen based on the results of interviews that had been conducted. The worksheets were created by gathering materials, images, and videos that would later become the worksheets' content. The material presented in the worksheets is based on the second-semester 7th-grade junior high school science textbook. The researcher used the junior high school science textbook as a reference to ensure the material remained appropriate for the students' cognitive abilities. The collected information was then organised in Microsoft Word into a draft of the LKPD content to facilitate the researcher's editing process. The layout of the LKPD content draft is shown in Figure 2.



Lembar Kerja Peserta Didik (LKPD)

Pencemaran lingkungan (air)

Disusun oleh :

Abiana elfarabi

Pendidkan ipa

Fmipa universitas negeri malang

Untuk SMP/MTs kelas vii

Kompetensi dasar

3.8 Menganalisis terjadinya pencemaran lingkungan dan dampaknya bagi ekosistem
4.8 Membuat tulisan tentang gagasan penyelesaian masalah pencemaran di lingkungannya berdasarkan hasil pengamatan.

Indikator

3.8.1. Menjelaskan pengertian pencemaran lingkungan
3.8.2. Menganalaisis macam-macam pencemaran lingkungan
3.8.3. Menjelaskan pengertian pencemaran air
3.8.4. Menganalisis pengaruh air jernih dari tercemar terhadap kondisi (pergerakan) ikan
4.8.1. Membuat gagasan tentang penyelesaian untuk mengatasi dan mengurangi pencemaran air.

Figure 2. Display of the LKPD Content

The content outline consists of a series of materials and information organised according to the PBL syntax (Herminarto et al., 2015). The implementation stages using the PBL model are presented in Table 2.

Table 2. PBL Syntax

Stage	Activity	Action
1	Orientation	Orient students to the problem.
2	Organization	Organising students into small-group discussions.
3	Investigation	Conducting investigations or experiments to gather information related to the problem.
4	Presenting Results	Students develop the results of their discussions and then present them.
5	Evaluation	Evaluate the problem-solving process presented by each group.

The next step is to transform the worksheet draft into a finalised version. The worksheet is created using the online editing platform Canva. The editing process using Canva is divided into two parts: creating the worksheet and developing the water pollution

content. The first part of the worksheet includes a cover page with the title, student information, the creator's name, and the school's name. This section is designed to be engaging so that students are motivated and interested in working on the worksheet. The next section contains instructions for completing the worksheet, followed by the main content, which begins with the Core Competencies (KI), Basic Competencies (KD), and learning objectives, and concludes with an evaluation section.

The second section covers water pollution. The water pollution material was developed separately to make the worksheets easier for students to use and to ensure it is well received. The water pollution material uses the 7th-grade junior high school science textbook as a reference so students do not get confused and the material is appropriate for their ability level. The water pollution material that was created was then uploaded to the publisher's website, Issuu. The link obtained from that website was then linked to the worksheet that had been created.

After completing the design of the PBL-based worksheets, a comprehensive evaluation was conducted. The content of the designed worksheets must be easy to understand and free of ambiguity. The evaluation results indicated that some questions did not align with the learning objectives and that the sources of the images and videos used were not cited. These evaluation results were then used as a basis for revising the developed PBL-based worksheets.

Development

The product development process involved transforming the worksheets into a tangible product integrated with the LiveWorksheet website. In this stage, the worksheets which had been created using Canva were uploaded to LiveWorksheet to be adjusted and formatted into a complete set of worksheets. The LKPDs uploaded to LiveWorksheet were configured to provide spaces for students to answer questions, and links to videos on water pollution, as well as to materials previously created and uploaded to the Issuu website, were added. These LKPDs were also supplemented with additional articles to provide students with supplementary knowledge to complement the data they collected. The questions presented consisted of 11 long-answer items.

The next stage involved validating the media and materials. Validation was conducted by a faculty member from the Science Education Program at Malang State University to gather comments and suggestions for improvement. The validation process was carried out using the prepared validation instrument. The results of the material validation for the developed worksheet are presented in Table 3.

Table 3. Content Validity of PBL-Based Worksheets on Environmental Pollution

Aspect	Score (%)	Criteria
Content Suitability	100	Highly Valid
Presentation Quality	100	Highly Valid
Language Appropriateness	95	Highly Valid
Conceptual Validity	100	Highly Valid
Average	98.8	Highly Valid

In addition to validating the content, it is also necessary to validate the media used in the developed student worksheets. The media validation results are presented in Table 4 below.

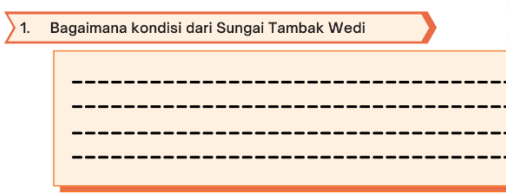
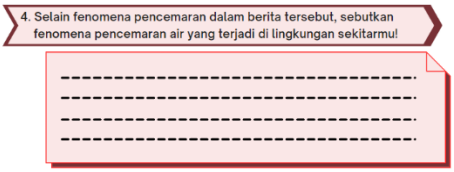
Table 4. Media Validation for PBL-Based LKPD Products on Environmental Pollution

Aspect	Score (%)	Criteria
Software	100	Highly Valid
Visual	100	Highly Valid
Average	**100**	**Highly Valid**

The material validation results in Table 5 yielded a material validation score of 98.8%, meeting the "highly valid" criterion. Similarly, Table 6 shows a media validation score of 100%, which falls within the "highly valid" category. Therefore, it can be concluded that the PBL-based worksheets on environmental pollution meet the "highly valid" criterion and can be implemented in the learning process. This is supported by the opinion of Akbar (2013) who states that learning materials can be implemented if the readability and validation percentages exceed 70% (Akbar, 2013). The validated worksheets can proceed to the next stage, namely implementation. In addition to the validation scores, suggestions and comments were also obtained to improve the developed worksheets.

The developed worksheets were then revised based on the comments and suggestions from the validators. Based on the feedback received, the worksheets were improved. These improvements focused primarily on writing techniques, *typos*, and ineffective vocabulary. Table 5 summarises the comments, suggestions, and improvements to the worksheets.

Table 5. Comments, Suggestions, and Revisions

No	Feedback	Before Revisions	After Revisions
1	Correct *typos* and ineffective sentences.		
2	Correct the text as shown *in* red	In addition to the pollution phenomenon mentioned in the news article, describe a water pollution phenomenon occurring in your local area	

Feedback was also provided by the validating faculty members, who noted that the worksheets were of good quality and easy to follow. The revised worksheets can then be pilot-tested in schools.

Implementation

The implementation phase involved piloting the developed worksheets with students in classes VIII A and VIII D at SMPN 17 Surabaya. The pilot was conducted to collect data on the worksheets' readability as assessed by the students. Students were asked to form groups of 2–3 people and then complete the worksheets provided. Students completed the worksheets online using their own devices. The worksheets completed by the students are shown in Figure 3.

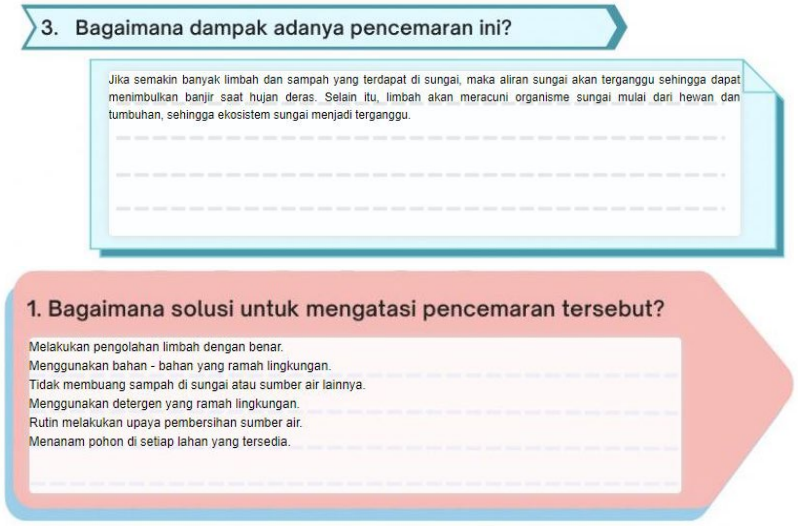


Figure 3. Results of Student Discussions

After completing the assignment up to the presentation stage, students presented the results of their discussion, specifically, their answers to the questions from the orientation section, followed by a presentation of their findings, which were then reviewed by other groups. The presentation outlined the students' discussion results and answered questions during the evaluation stage. This was followed by a readability test. The readability test was conducted using a prepared response questionnaire, which students completed via *Google Forms.* The readability test results are presented in Table 6.

Table 6. Results of the Readability Test by Students

Aspect	Score (%)	Criteria
Content Suitability	87.3	Highly Appropriate
Presentation Quality	86.7	Highly Appropriate
Average	87%	Highly Appropriate

The readability test scores for students in classes VIII A and VIII D, as shown in Table 7, yielded an overall readability test score of 87%, which falls into the "highly acceptable" category. This aligns with the opinion of Akbar(2013), who states that instructional materials can be implemented if the readability and validation rates exceed 70% (Akbar, 2013). A good readability level can increase readers' interest in learning and memory retention, improve reading speed and efficiency, and maintain reading habits (Dewi & Arini, 2018).

In this stage, a practicality test was conducted by two science teachers at SMPN 17 Surabaya. The practicality test results for the worksheet product are presented in Table 7.

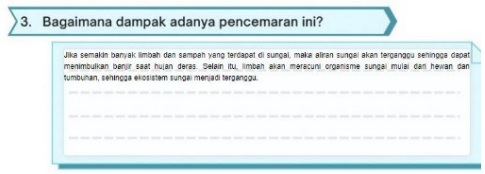
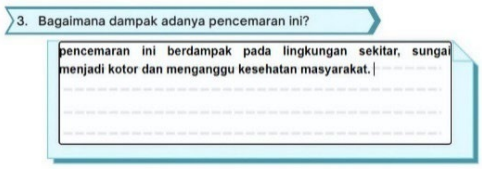
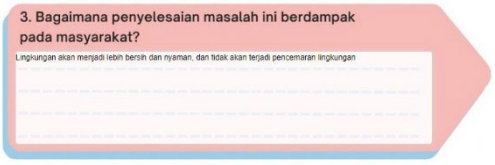
Table 7. Results of the Practicality Test by Educators

Aspect	Educator 1		Educator 2	
	Score (%)	Criteria	Score (%)	Criteria
Content Suitability	100	Very Practical	100	Very Practical
Appearance Suitability	93.8	Very Practical	93.8	Very Practical
Content Relevance	100	Very Practical	100	Very Practical
Efficient	87.5	Very Practical	87.5	Very Practical
Language Appropriateness	100	Very Practical	93.8	Very Practical
Average	96.3	Very Practical	95	Very Practical
Total Average	95.7		Very Practical	

The practicality test score for Educator 1 was 96.3%, falling into the "very practical" category, while Educator 2 scored 95%, also falling into the "very practical" category. The overall practicality test result was 95.7%, which falls into the "very practical" category. The practicality of instructional media is a key requirement in developing instructional media in the form of software, specifically, that it be easy for users to use. (Annisa et al., 2020) . In addition to the practicality test scores, suggestions and comments regarding the worksheets were collected.

The evaluation, based on comments and suggestions from both science teachers and students, served as a reference for the researchers to improve the developed worksheets. Based on the suggestions and comments received, the worksheets were subsequently revised accordingly. The revisions addressed the font size in the answer columns, which was too small, and the placement of the answer columns, which obscured the questions. Table 8 summarises the comments, suggestions, and revisions to the worksheets.

Table 8. Comments, Suggestions, and Revisions

No	Comments and Suggestions	Before Revisions	After Corrections
1	The font size in the answer column is too small		
2	The answer column is arranged so that it does not obscure the question		

In addition to suggestions for improvement, responses also supported the suitability of the developed LKPD media. These responses were obtained from educators and students. A summary of the responses is presented in Table 9.

Table 9. Feedback

No	Feedback
1.	The LKPD is good and can be applied in the learning process
2.	The LKPDs are in line with the existing curriculum
3.	The worksheets included in this topic meet the established criteria and are suitable for distribution to students.
4.	The worksheets can be used for other topics.
5.	The worksheets make learning more engaging
6.	The explanations in the worksheets are easy to understand
7.	The link for submission is quite difficult to use

Based on the feedback provided, the developed LKPDs are in accordance with the procedures for LKPD development, as explained by (Prastowo, 2014) which states that LKPD development has three requirements: didactic, construction, and technical. The didactic requirement stipulates that worksheets must adhere to the principles of effective teaching and learning; therefore, good worksheets can be used effectively by all students and emphasise the process of discovering concepts. The construction requirement pertains to the language, level of difficulty, and clarity of the worksheets, which must be appropriate so students can understand them. Meanwhile, the technical requirement concerns the visual presentation of the worksheets, such as the attractiveness of the illustrations, the use of typefaces, and the clarity of the overall images (Prastowo, 2014) .

CONCLUSIONS

Based on the results of the tests conducted, it can be concluded that the PBL-based worksheets developed are highly valid and highly suitable for use in science instruction on the topic of environmental pollution. The material and media validation results yielded average scores of 98.8% and 100%, respectively, which fall into the "highly valid" category. The practicality test by educators yielded an average score of 95.7%, which falls into the "highly practical" category. Meanwhile, the media readability test by students yielded an average score of 87%, which falls into the "highly suitable" category, along with the "highly practical" category. Based on the results of this study, it can be stated that PBL-based worksheets can be implemented in junior high school science instruction on the topic of environmental pollution. The researcher recommends that future researchers develop worksheets with a wider variety of question types, test their effectiveness with students, and adapt them to other topics by aligning them with the applicable curriculum. Once the worksheets are validated and proven effective, they can be distributed for use in classroom instruction.

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AI-ASSISTED TECHNOLOGY STATEMENT

While preparing this work, the authors used ChatGPT and Grammarly to improve language clarity and detect grammatical errors.

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