Development of an offline problem-based learning electronic student worksheet (E-LKPD) to enhance students' scientific literacy

Desnalitya Zachawerus[1*], Meike Paat[2], Jovialine Albertine Rungkat[3], Rolles Nixon Palilingan[4], Masje Wurarah[5] and Ferny Margo Tumbel[6]

[1] Master's Program in Science Education, Postgraduate Program, Manado State University, Indonesia

[2-6] Science Education Study Program, Postgraduate Program, Manado State University, Indonesia

Corresponding author: Desnalitya Zachawerus

Received 22 Aug 2025; Accepted 6 Oct 2025; Published 17 Oct 2025

DOI: https://doi.org/10.64171/JAES.5.4.37-48

Abstract

This study developed and validated an offline electronic student worksheet (E-LKPD) grounded in the Problem-Based Learning (PBL) model to enhance science literacy among eighth-grade students in the science subject at SMP Negeri 1 Siau Timur Selatan. Employing a Research and Development design supported by the ADDIE model, the study proceeded through stages of needs analysis, design, development, implementation, and formative evaluation. Data were collected through interviews, expert-validation questionnaires for material and media components, and product testing with teachers and students. The material expert provided a final validity score of 94%, while the media expert assigned a final score of 97%, both classified as "excellent," indicating that the product is feasible for classroom use. Teacher evaluation yielded a score of 95% ("excellent"), demonstrating strong acceptance of the E-LKPD as a learning resource. Student responses in small-scale and large-scale trials resulted in scores of 93% and 92%, respectively, both within the "excellent" category, signifying high usability and positive learning experiences. These findings confirm that the offline PBL-based E-LKPD is valid, practical, and appropriate for supporting science learning in limited-Internet contexts, and it effectively promotes students' science literacy development.

Keywords: Offline E-LKPD, Problem-Based Learning, Science literacy, Science education, Instructional media

1. Introduction

The 1945 Constitution mandates that the national goal of Indonesian education is to cultivate an enlightened and intellectually capable society. This principle underpins all educational efforts, including the imperative to design learning experiences that are responsive to contemporary developments. In the era of globalization and the Fourth Industrial Revolution, education is expected not only to transmit knowledge but also to nurture human resources who are capable of critical and creative thinking and who can effectively address real-world problems (Rachmad, *et al*., 2024) [24].

Despite these expectations, significant challenges persist within Indonesia's education system. One major concern is students' low level of scientific literacy. Scientific literacy encompasses the ability to understand scientific concepts, apply scientific knowledge in everyday contexts, and utilize evidence-based reasoning to solve problems. Numerous studies indicate that many Indonesian students struggle to connect the science content they learn in school with real-world phenomena. They also lack sufficient learning experiences that foster logical, rational, and systematic thinking. (Sain, *et al*., 2024; Siregar, *et al*., 2019; Setiawan & Suwandi, 2022) [26, 29, 28].

According to the National Research Council, scientific literacy represents a central objective in science education because it aims to ensure that students do not merely acquire conceptual knowledge but also develop scientific competencies and attitudes applicable to everyday life. Scientific literacy further influences the overall quality of science instruction; when learning incorporates literacy-oriented activities, students experience more meaningful engagement by strengthening their conceptual understanding and applying scientific principles in novel and authentic contexts. One instructional model widely recognized for enhancing scientific literacy is Problem-Based Learning (PBL), which encourages learners to engage with real-world problems, think critically, and develop inquiry skills (Osborne, 2023; Paat, Warouw & Mokalu, 2025) [15, 20].

Observations at SMP Negeri 1 Siau Timur Selatan reveal that students' scientific literacy in science subjects remains low. Students experience difficulty linking lesson content to everyday phenomena and often fail to draw independent conclusions during the learning process. The 2024 National Assessment similarly places students' literacy levels in the low category. Consistent with classroom observations, students show limited performance on tasks aligned with scientific literacy indicators such as explaining phenomena, identifying scientific issues, using evidence, and applying scientific concepts in varied contexts.

One potential solution for improving scientific literacy is the integration of digital platforms, which can cultivate technologically adept learners and sustain motivation in the context of Industry 4.0. Technology-based media in science instruction have been shown to enhance student learning, increase engagement, and reduce boredom by presenting content more attractively and interactively. (Chang, Kuo & Dua, 2023) [1].

Interviews with science teachers at SMP Negeri 1 Siau Timur Selatan (September 2024) indicate that although conventional printed worksheets (LKPD) are used in group activities, their implementation remains problematic. Not all students receive copies due to printing constraints, and the content does not consistently promote analytical and critical thinking. Meanwhile, electronic worksheets (E-LKPD) cannot be optimally utilized because geographic and infrastructural limitations hinder stable Internet access. Many students encounter difficulties in online learning owing to network instability and limited data quotas, demonstrating that online-based digital learning media cannot yet be fully implemented.

An offline E-LKPD emerges as a feasible solution. As a digital learning medium, it can present content in an interactive, diverse, and engaging manner without relying on Internet connectivity. Prior research shows that E-LKPD use can enhance students' motivation, interest, and learning outcomes (Suryaningsih & Nurlita, 2021:1264). Integrating PBL principles into the offline E-LKPD further enables students to actively engage in problem-solving rather than passively receiving information, thereby strengthening their scientific literacy. This offline format is particularly well-suited to the contextual constraints of SMP Negeri 1 Siau Timur Selatan, as it ensures accessibility irrespective of Internet availability.

Student Worksheets (Lembar Kerja Peserta Didik/LKPD) are instructional materials consisting of task sheets that students must complete. Within learning resources, an LKPD provides directions and step-by-step guidance for accomplishing specific tasks. The basic competencies targeted through the LKPD must be clearly articulated to ensure that assigned activities align with the intended learning outcomes. LKPDs function as instructional tools that support teachers in managing the learning process and in cultivating students' scientific skills and dispositions. (Patibang, *et al*., 2025; Pertiwi, Paat & Lihiang, 2023) [22, 23].

PBL-based LKPDs have been shown to facilitate students' conceptual understanding and their ability to solve mathematical problems. Such PBL learning tools guide learners to accurately identify problems, formulate problem statements, and determine appropriate solution strategies, ultimately enabling them to arrive at effective resolutions. (Domits, *et al*., 2025; Sanudin, *et al*., 2023; Paat, *et al*., 2024) [3, 27, 17].

Development of Electronic LKPD (E-LKPD)

Educational development refers to a systematic effort to design a product, construct or produce its prototype, and evaluate its performance in order to generate empirical evidence that informs the creation of models or tools for educational or non-educational use. (Giacumo & Breman, 2021; Paat, *et al*., 2025; Kahar, *et al*., 2020) [4, 20, 6].

An E-LKPD is a digital learning guide designed to help students comprehend subject matter more easily, which can be accessed via computers, laptops, smartphones, or other mobile devices. The primary benefits of E-LKPDs include facilitating learning activities, enhancing students' understanding of instructional content, and making the learning process more engaging and interactive. E-LKPDs also stimulate curiosity and encourage students' physical and emotional engagement with learning materials. (Hamidah, Ayunasari, & Sanjaya, 2023) [5].

Several key considerations in designing LKPDs:

- The content must be aligned with the basic competencies to be achieved, and may include supporting information that outlines the scope of the material.
- Learning materials can be sourced from books, journals, magazines, online resources, and research publications.
- To reinforce conceptual understanding, LKPDs should include references that enable students to explore the material further.
- All tasks must be stated clearly to reduce confusion, particularly for discussion-based assignments, which should specify the topic, group composition, discussion partners, and duration.

Problem-Based Learning (PBL) approach

Problem-Based Learning is a student-centered instructional model in which real-world problems are introduced at the beginning of instruction. This approach helps learners develop collaborative skills and understand how to engage in problem solving relevant to everyday life. PBL as an instructional model grounded in authentic investigation, requiring students to engage in inquiries that demand real and meaningful solutions. (Paat & Mokalu, 2023; Kindangen, *et al*., 2023) [21, 8].

PBL focuses on specific themes with the goal of helping learners acquire content knowledge, problem-solving skills, and the ability to analyze real-world issues. The model encourages students to become analytical, investigative, and innovative, rather than merely memorizing information. It also provides opportunities for active participation through discussion and collaborative exploration (Kembuan, *et al*., 2019; Manein, *et al*., 2025) [7, 10].

Problem-based learning requires students to go beyond listening to lectures, taking notes, and reproducing information provided by the teacher. PBL is an innovative approach that promotes active learning by engaging students in solving problems through scientific procedures. This process enables students to develop both conceptual understanding and essential problem-solving skills (Manein, *et al*., 2025; Mokalu, *et al*., 2023; Paat, *et al*., 2021) [10, 14, 16].

In everyday life, literacy skills are essential for accomplishing various goals. Within educational settings, literacy manifests in several forms, one of which is scientific literacy. Scientific literacy is a crucial skill for navigating the globalized era because it enables learners not only to observe phenomena but also to apply scientific ideas in their daily activities (Paat, *et al*., 2024) [18].

Scientific literacy refers to an individual's ability to understand, communicate, and apply scientific knowledge to solve problems, thereby fostering awareness and sensitivity toward the surrounding environment. Scientific literacy encompasses competencies such as using scientific knowledge, identifying questions, drawing evidence-based conclusions, as well as explaining and predicting phenomena for problem-solving purposes. (Sondakh, *et al*., 2021) [30].

The Programme for International Student Assessment (PISA) defines scientific literacy as an individual's capacity to utilize scientific knowledge, identify scientific issues, and draw conclusions based on scientific evidence regarding real-world issues in order to understand and make informed decisions about natural phenomena and human–environment interactions. Scientific literacy also involves the ability to apply scientific concepts in daily life, explain scientific events, and justify interpretations using empirical evidence.

Research literature identifies various indicators of scientific literacy, including the ability to think critically, communicate effectively, collaborate in problem solving, generate creative solutions, identify and analyze scientific data, logically explain scientific phenomena, apply scientific methods in investigations, evaluate scientific information, understand the societal implications of scientific knowledge, and identify research questions.

Several factors contribute to students' low scientific literacy. These include traditional instructional practices in science education that overlook reading and writing as core scientific competencies; limited ability to interpret graphs or tables because students are accustomed only to filling in prepared templates; lack of exposure to scientific literacy–based questions; and students' limited understanding of fundamental scientific concepts taught by teachers.

Grant and Lapp, as cited in Rini, Hartantri, and Amaliyah (2021:171), emphasize that prospective science teachers must be able to promote scientific literacy using various strategies, such as identifying relevant and engaging topics, training students to read scientific research reports, and encouraging them to read and think like scientists.

2. Materials and Methods

A. Problem-Based Learning (PBL) Model

a) Definition of the Problem-Based Learning (PBL) Model

The Problem-Based Learning (PBL) model is an instructional approach in which students collaborate in groups to identify a problem and work together to find a solution. This model facilitates students in collaboratively identifying problems and developing the skills to address real-world issues that are closely connected to their everyday lives. Problem-Based Learning presents contextually relevant problems that stimulate students to engage in learning. This approach is considered effective for helping students process information and construct their own knowledge about the social world and their surroundings. Describe Problem-Based Learning as a model that begins with presenting real-world problems, actively involving students in solving those problems, thereby increasing their motivation and curiosity. This model serves as a platform for students to develop higher-order thinking skills and critical thinking abilities. (Magdalena, *et al*., 2021; Manein, *et al*., 2025; Lelamula, *et al*., 2022; Paat, *et al*., 2021; Darumba, *et al*., 2025) [10, 16, 2].

In summary, Problem-Based Learning is an instructional model that enables students to work collaboratively with their peers to solve context-based problems using their existing knowledge and experiences, fostering the development of critical thinking skills.

b) Steps of the Problem-Based Learning (PBL) Model

The steps of the Problem-Based Learning model, are as follows:

- Orienting students to the problem;
- Organizing students to learn;
- Guiding individual and group investigations;
- Developing and presenting work products;
- Analyzing and evaluating the problem-solving process.

Furthermore, Sugiyanto, as cited in S. S. Dewi *et al*. (2022, p. 381), outlines the steps of Problem-Based Learning as follows:

- Orienting the problem by forming groups of 4–5 students;
- Organizing students and guiding them in conducting case analyses;
- Collecting resources as materials to solve the case;
- Developing and presenting the results of discussions in either discussion or presentation formats;
- Analyzing and evaluating the process and outcomes of the case solution.

Based on these frameworks, teachers can design contextually relevant problem-based learning steps for implementation in the classroom.

c) Advantages of the Problem-Based Learning (PBL) Model

The advantages of the Problem-Based Learning model include:

- More meaningful student learning;
- Increased student capacity for critical thinking;
- Easier comprehension of concepts taught;
- Enhanced student activity and creativity in problem-solving;
- Improved student collaboration in groups.

Additionally, identifies the following advantages:

- Increased student motivation and learning activities;
- Assistance in transferring knowledge to understand real-world problems;
- Opportunities for students to develop new knowledge;
- Enhanced critical thinking skills;
- Opportunities for students to apply their knowledge in real-world contexts;
- Facilitation of concept mastery for solving authentic problems.

d) Limitations of the Problem-Based Learning (PBL) Model

The limitations of the Problem-Based Learning model include:

- It cannot be applied to every subject matter;
- Some teachers may be overly active in delivering content;

- It is more suitable for subjects that emphasize specific problem-solving skills;
- In classes with high student diversity, it may be challenging to assign tasks effectively.

Similarly, outlines the following limitations:

- Some subject matter is very difficult to teach using the Problem-Based Learning model;
- It requires considerable time allocation;
- Instruction is primarily based on problem-solving. (Hasanah & Fitria, 2021; Tengor, *et al*., 2023; Kindangen, *et al*., 2023; Pasaribut, *et al*., 2024; Tauri, 2023; Tangdilian, 2023; Rengkuan, *et al*., 2024) [8],

B. Instructional media

a) Definition of quizizz as instructional media

Instructional media plays a crucial role in the learning process. Instructional media refers to tools used by teachers to facilitate the delivery of information or instructions to students during the learning process and can be tailored to meet the needs of students throughout the teaching and learning activities to achieve learning objectives. (Haddar & Juliano, 2021; Pertiwi, *et al*., 2023; Sanudin, *et al*., 2023) [23, 27].

Quizizz is an educational game application that is both narrative and flexible, serving not only as a medium to deliver learning material but also as an engaging and enjoyable tool for formative assessment. By utilizing Quizizz as instructional media, teachers can create a more dynamic learning atmosphere that enhances the achievement of learning objectives. According to Citra and Rosy (2020, p. 264), Quizizz is an educational game-based learning platform that includes interactive quizzes commonly used for activities such as pre-tests, post-tests, practice exercises, content reinforcement to assess student understanding, remedial activities, and homework assignments, featuring diverse answer choices with images and colors.

In summary, the Quizizz application as instructional media is an educational game-based application that serves as both a platform for delivering learning material and an engaging and enjoyable tool for formative assessment. It can be used in learning activities such as pre-tests, post-tests, and practice exercises, with answer choices that include varied images and colors.

3. Research methodology

The development of this E-LKPD employed a Research and Development (R&D) methodology using the ADDIE instructional design model. R&D is a research approach used to produce a specific product and to evaluate its effectiveness (Sugiyono in Umaroh *et al*., 2022). According to Cahyadi (in Nurani, 2024), the ADDIE model consists of five sequential phases: Analysis, Design, Development, Implementation, and Evaluation.

Development procedure

A. Analysis phase (Analyze)

a) Needs analysis

Needs analysis aims to identify the existing conditions and learning issues at the research site. The researcher examined problems encountered in science learning through classroom observations, student needs assessments, and interviews with science teachers.

b) Material analysis

This step focuses on determining the content requirements for developing learning materials by referring to the curriculum applied in the target school and aligning the material with learning outcomes and instructional objectives. Based on interviews with the eighth-grade science teacher, the material selected for development concerns the structure and functions of living organisms.

c) Media analysis

Media analysis examines the types of instructional media commonly used by science teachers at SMP Negeri 1 Siau Timur Selatan. Observations and interviews revealed that teachers typically utilize videos, PowerPoint presentations, and worksheets (LKPD).

B. Design phase (Design)

At this stage, the researcher created a preliminary design for the instructional media based on data collected during the analysis phase. The design serves as a reference framework for producing the E-LKPD.

a) Product development timeline

Development began in June 2025, starting with designing the product layout, gathering relevant learning materials, and initiating the construction of the E-LKPD.

b) Development team

Developing the E-LKPD requires a collaborative team with distinct roles. The team consists of the researcher as the product developer, expert validators responsible for assessing the product, and teachers and students who serve as evaluators during small- and large-group trials.

c) Product creation process

The researcher designed the E-LKPD following the predetermined concept and storyboard. Canva and Google Forms were used to create the product in accordance with the design guidelines. (Tumbel, *et al*., 2022; Kosakoy, *et al*, 2025; Mantiri, *et al*., 2025) [31, 9, 11] The overall structure of the E-LKPD is summarized in Table 1 and Table 2.

Table 1: E-LKPD Structure

Section	Components
Cover	Tut Wuri Logo, Title, Relevant Illustration, Grade and Semester
Content	Learning Outcomes, Learning Objectives, Group Identity, PBL-Based Activities
Closing	Glossary

Storyboard structure

A storyboard is developed to describe the layout, visual elements, and instructional flow. Key sections include:

A. Cover page

- Tut Wuri Logo
- Title
- Cover Illustration
- Author Name
- Institution
- Grade and Semester
- The cover is designed using Canva with relevant imagery reflecting the human circulatory system.

B. Learning outcomes

- Adapted from the curriculum used at the target school
- Includes instructions for using the E-LKPD.

C. Learning objectives & group identity

- Learning objectives align with instructional progression
- Space provided to list group members.

D. Usage instructions & brief material

- Contains guidelines for navigating the E-LKPD
- Includes essential content about the human circulatory system and an embedded instructional video.

E. PBL-based activities

- Structured according to PBL syntax
- Includes images, videos, and written tasks requiring group discussion and problem-solving.

F. Glossary and references

- Provides key terms and the references used in developing the E-LKPD.

Development phase (Development)

This phase involves producing the electronic worksheet on the topic of structure and function in living organisms, followed by expert validation to determine its appropriateness for classroom use.

i. Material validation

Material validation is conducted using a validation questionnaire completed by experts in science education. The purpose is to ensure that the material included in the E-LKPD is accurate, coherent, and aligned with curriculum requirements.

ii. Product validation

The product is evaluated by media experts and material experts to determine its feasibility. Validation assesses content accuracy, presentation techniques, contextual relevance, visual design, and technical quality. Validators are science education lecturers experienced in instructional media assessment.

iii. Product revision

Revisions are made based on validator feedback to address any deficiencies or weaknesses in the design. Suggestions from expert reviewers guide improvements to the product before implementation.

Implementation phase (Implementation)

Implementation refers to the step in which the developed E-LKPD is applied in an actual learning setting. After being revised and deemed feasible, the product is tested in a small-group trial involving approximately five students and a large-group trial involving around thirty students.

Data collection during implementation uses questionnaires to gather both qualitative feedback and quantitative assessments of product feasibility. Qualitative data include suggestions for improvement from experts, while quantitative data are obtained from students during product trials.

Evaluation phase (Evaluation)

Evaluation in this study is conducted formatively through media validation, material validation, and product trials. Formative evaluation involves reviewing and assessing the development process while it is ongoing to ensure improvements are made continuously. This evaluation aligns with the notion that formative assessments are conducted during the early or ongoing stages of program implementation (Sondakh, *et al*., 2021; Mokalu, *et al*., 2024) [30, 13].

The trial subjects in this study were eighth-grade students at SMP Negeri 1 Siau Timur Selatan, selected in July 2025. The product was tested in two stages: a small-group trial involving five students and a large-group trial involving thirty students. The research generated both qualitative and quantitative data. Qualitative data were obtained from interviews with science teachers, comments and suggestions from expert validators, as well as feedback from teachers and students during product assessment. Quantitative data were derived from validation scores provided by material and media experts and from student and teacher responses to their use of the E-LKPD on the topic of the structure and function of living organisms.

Data were collected using several instruments, including observations, needs-analysis questionnaires, interview guides, documentation, product validation instruments, and user-response questionnaires. Structured interviews with the science teacher were conducted to identify instructional problems encountered in the classroom. Questionnaires were used to collect data from experts, teachers, and students, adopting a Likert scale with four response options. Positive statements were scored from 4 to 1, whereas negative statements were scored inversely. The material-validation questionnaire assessed content accuracy and relevance; the media-validation questionnaire assessed design, presentation, and technical aspects; and the product-trial questionnaires measured teacher and student responses to the revised E-LKPD.

Data analysis involved both qualitative and quantitative procedures. Qualitative data from expert comments were analyzed descriptively to guide product revision. Quantitative analysis used Likert-scale scores, which were converted into percentage values to determine the validity and feasibility of the E-LKPD. The interpretation categories ranged from "very good" to "very poor," depending on score intervals established by previous literature. Media and material were categorized as valid if they fell within the "good" or "very good" ranges, while lower categories indicated the need for further revision. Similar classification procedures were applied to small-group trials (five respondents), large-group trials (thirty respondents), and the teacher-response assessment (ten statements). Final product feasibility was determined using percentage-based criteria indicating whether the E-LKPD was very attractive, attractive, less attractive, or not attractive.

4. Results & Discussion

The development research conducted in this study produced several key outcomes. First, an offline E-LKPD based on the Problem-Based Learning model was successfully developed to enhance students' scientific literacy in the eighth-grade science curriculum at SMP Negeri 1 Siau Timur Selatan. Second, the product underwent validation by both material and media experts, who concluded that the E-LKPD met the required feasibility standards for classroom trial. Third, the science teacher provided an evaluation of the offline PBL-based E-LKPD, and fourth, the students also assessed the product after its use in learning activities.

The development of the offline E-LKPD followed the ADDIE model, consisting of the Analysis, Design, Development, Implementation, and Evaluation phases.

A. Analysis phase

a) Needs analysis

The needs analysis was conducted to identify the instructional requirements of the science teacher. Interviews and classroom observations showed that students' scientific literacy at SMP Negeri 1 Siau Timur Selatan remained low. Although Problem-Based Learning is an appropriate model for supporting inquiry and critical thinking, the implementation of online E-LKPDs was not feasible due to infrastructural limitations. Internet connectivity in the area was unstable, often disrupted by power outages, and students lacked sufficient internet quota because the school did not provide free Wi-Fi. These conditions confirmed the need for an offline PBL-based E-LKPD to support science instruction and improve students' scientific literacy.

b) Material analysis

Material analysis was conducted by reviewing the curriculum used in the school. In the Merdeka Curriculum, one of the core topics in the Grade VIII science textbook published by the Ministry of Education, Culture, Research, and Technology is the human circulatory system. This topic is closely related to real-life phenomena and requires students to analyze contextual problems. Therefore, it is well suited for Problem-Based Learning, which can strengthen students' scientific literacy, critical thinking, and inquiry skills.

c) Media analysis

Media analysis showed that teachers generally used printed worksheets (LKPD) in the form of loose sheets. Thus, the development of an offline E-LKPD was considered necessary to motivate students and facilitate independent learning without relying on an internet connection.

B. Design phase

The design phase involved creating the blueprint and structure of the PBL-based E-LKPD using Canva and Docfly, resulting in a PDF-format product distributed to students. The materials included in the offline E-LKPD were aligned with the Grade VIII topic on the human circulatory system.

a) Product development timeline

The development process took place from June to August 2025, beginning with the initial design of the product, collection of relevant learning material, construction of the E-LKPD, and expert validation from material and media specialists.

b) Product development team

The development team consisted of:

- The researcher, who served as the developer of the PBL-based offline E-LKPD aimed at improving students' scientific literacy in Grade VIII science.
- Supervisors who acted as expert validators:
  - Dr. Ferni Tumbel, M.S., as the media expert
  - Dr. Anatje Lihiang, M.Si., as the material expert

c) Product development stages

Initial design of the E-LKPD

- **Cover design**

The cover page of the E-LKPD was designed to reflect both its academic purpose and the thematic relevance of the content. The cover consists of the *Tut Wuri Handayani* logo, the title of the instructional material, and an illustrative image related to the human circulatory system. It also includes the author's name, the school name, and the designated grade level. An example of this cover layout is presented in Figure 1.

Fig 1: LKPD Cover

- The learning outcomes section presents the competencies that students are expected to achieve, as outlined in the applicable curriculum. This component ensures that the content and activities in the E-LKPD align with the mandated learning standards and instructional objectives. The initial display of the learning outcomes is shown in Figure.

Fig 2: Initial display of learning outcomes

- **Learning objectives**

The learning objectives section outlines the specific competencies and skills that students are expected to achieve upon completing the learning activities. These objectives guide the structure of the E-LKPD and ensure that each activity supports the intended instructional outcomes. The initial display of the learning objectives is shown in Figure 3.

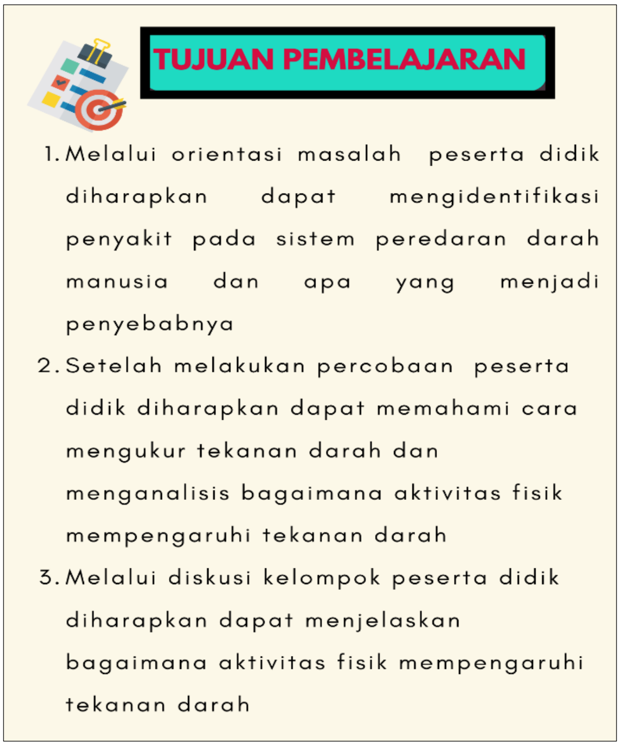

Fig 3: The initial display of the learning objectives

- **User instructions**

The user instructions section provides guidance on how students should navigate and use the E-LKPD throughout the learning process. This component ensures that learners clearly understand the sequence of activities, the functions of each section, and the steps required to complete the assigned tasks. The initial display of the user instructions is presented in Fig 4.

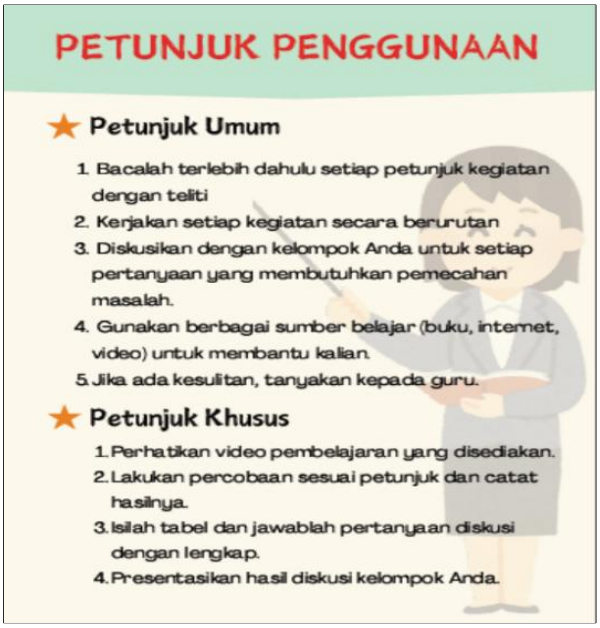

Fig 4: The initial display of the user instructions

- **Brief learning material**

The brief learning material section contains a concise explanation of the human circulatory system, serving as the core content for students to review before engaging in problem-based activities. This section is complemented by an instructional video, which is provided through a scannable barcode to facilitate easy access. The initial display of the brief learning material is shown in Figure 5.

Fig 5: The initial display of the brief learning material

- **PBL-based group discussion activities**

The group discussion activities are structured according to the syntax of the Problem-Based Learning (PBL) model. These activities guide students through a series of inquiry-oriented steps designed to strengthen their scientific literacy and problem-solving abilities. The PBL syntax includes:

- Problem Orientation, in which students are introduced to a real-world issue related to the human circulatory system;
- Organizing Students for Learning, where learners are grouped and assigned roles to support collaborative investigation;
- Guided Inquiry, during which students explore relevant information, analyze data, and formulate explanations;
- Developing and Presenting Work, where groups construct and communicate their solutions in written or visual form; and
- Analyzing and Evaluating the Problem-Solving Process, which involves reflecting on the strategies used and evaluating the effectiveness of the solutions produced.

These structured stages ensure that the E-LKPD supports active learning, critical thinking, and the development of inquiry skills within a problem-based framework.

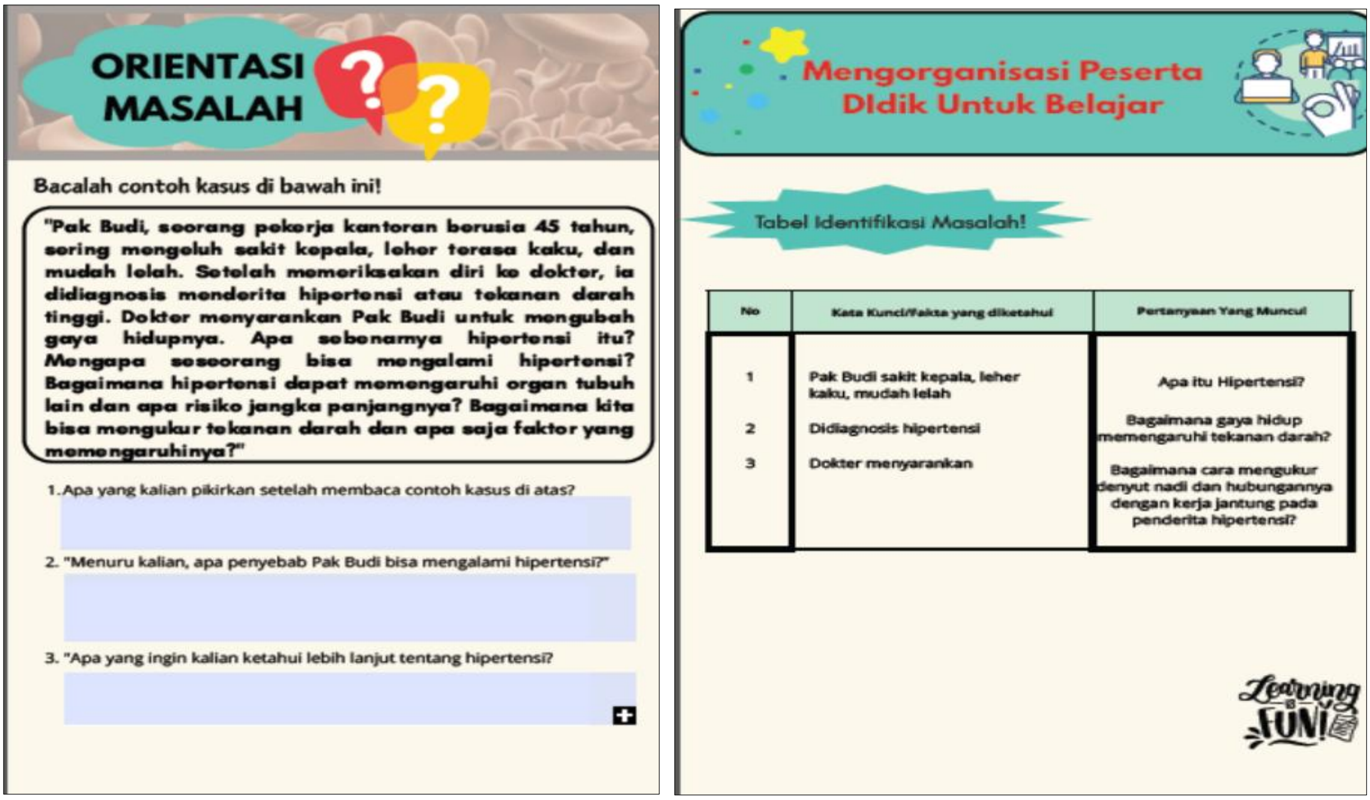

Fig 6: The initial display of the PBL-based activities

5. Development phase

Material expert validation

Results of material validation

The Offline E-LKPD based on Problem-Based Learning (PBL), developed to enhance students' scientific literacy in the Grade VIII science curriculum at SMP Negeri 1 Siau Timur Selatan, underwent two rounds of validation by a material expert. The first validation assessed the coherence, accuracy, and alignment of the content with curriculum standards and the intended learning outcomes. The results, including expert comments and recommendations, are summarized in Tables 2.

Table 2: Material validation stage I

Assessment Aspect	Description	Score	Notes
Alignment with Competencies			
1. Alignment of the material with SK/KD/Curriculum	3	Adequately aligned	
2. Alignment of the material with Learning Outcomes and learning objectives	3	Adequately aligned	
3. Clarity of instructions for using the offline E-LKPD	2	Not aligned; instructions should follow PBL syntax	
4. Systematic organization of the offline E-LKPD	2	Not yet aligned	
5. Logical arrangement of concepts in the offline E-LKPD	3	Aligned	
Material Feasibility			
6. Material suitability with learning objectives	3	Aligned	
7. Relevance of E-LKPD content to student needs	3	Adequately aligned	

8. Clarity and comprehensibility of material for students	2	Not aligned; add instructional videos	
9. Clarity of images presented	2	Not yet aligned; add more relevant images	
10. Clarity of videos presented	3	Adequately aligned	
11. Alignment of E-LKPD activities with material content	3	Aligned	
12. Relevance and attractiveness of activities	3	Adequately aligned	
Evaluation			
13. Ability of E-LKPD activities to enhance scientific literacy	3	Adequately aligned	
14. Alignment of activities with PBL syntax	2	Not aligned; include problem identification and hypothesis formulation	
Language Feasibility			
15. Use of language according to official Indonesian language standards	2	Not aligned	
16. Clarity and comprehensibility of language for students	2	Not aligned; certain terms need revision	
Total Score	41		
Maximum Score	64		
Percentage	64%		
Category	Good		
General Conclusion	Further revision is required before field testing		

Based on the results presented in Table 2. the first stage of material validation indicated that the developed product was not yet suitable for implementation and required several revisions. The expert assigned a score of 41 out of 64, corresponding to 64%, categorized as *Good*. Although the product met some essential criteria, the validator recommended multiple improvements to ensure the E-LKPD met the expected quality standards.

Key revisions suggested by the expert included clarifying usage instructions in accordance with PBL syntax, improving the systematic organization of the material, adding learning videos and more relevant images, restructuring activities to incorporate problem identification and hypothesis formulation, and refining the language to enhance readability and accuracy. Feedback from the expert indicated that improvements were necessary in the clarity of instructions, alignment with the PBL syntax, addition of relevant instructional videos, enhancement of visual materials, and refinement of linguistic elements to ensure readability. Additionally, the expert suggested incorporating explicit prompts for problem identification and hypothesis formulation to strengthen the structure of PBL-oriented activities.

Following these recommendations, revisions were made to the content and structure of the E-LKPD for the second validation stage. The results of the subsequent validation are presented in Table 3.

Table 3: Material validation – Phase II

Assessment Aspect	**Description**	**Score**	**Remarks**
Alignment with Competencies			
1. Alignment of material with the curriculum	4	Appropriate	
2. Alignment of material with Learning Outcomes	4	Appropriate	
3. Clarity of offline E-LKPD usage instructions	3	Moderately Appropriate	
4. Systematic presentation of the offline E-LKPD	4	Appropriate	
5. Systematic arrangement of offline E-LKPD concepts	4	Appropriate	
Material Feasibility			
6. Material suitability with learning objectives	4	Appropriate	
7. Material relevance to students' learning needs	4	Appropriate	
8. Material clarity and comprehensibility for students	3	Moderately Appropriate	
9. Accuracy and relevance of images	4	Appropriate	
10. Accuracy and relevance of instructional videos	4	Appropriate	
11. Alignment of activities with the material	3	Moderately Appropriate	
12. Relevance and attractiveness of activity presentation	4	Appropriate	
Evaluation			
13. Ability of the offline E-LKPD to enhance students' scientific literacy	3	Moderately Appropriate	
14. Alignment of activities with the PBL syntax	4	Appropriate	
Language Feasibility			
15. Language accuracy according to standard Indonesian (KBBI)	4	Appropriate	
16. Language clarity and comprehensibility for students	3	Moderately Appropriate	
Total Score	59		
Maximum Score	64		

Percentage	92%		
Category	Very Good		
General Conclusion	Suitable for implementation		

Based on the results presented in Table 3, the material expert's second validation yielded a total score of 59 out of 64, equivalent to a 92% rating, which falls under the "Very Good" category. These findings indicate that the material contained within the offline E-LKPD is valid, well-structured, and feasible for implementation in classroom settings. The expert noted substantial improvement from the first validation stage, particularly in the organization of content, alignment with curriculum standards, presentation quality, and integration of relevant visuals and videos.

Although a few elements such as the clarity of instructions and language refinement were rated as "Moderately Appropriate," these were considered minor and did not hinder the overall feasibility of the product. Consequently, the offline E-LKPD was deemed ready for trial implementation with students.

The Offline E-LKPD based on Problem-Based Learning (PBL), developed to enhance students' scientific literacy in the Grade VIII science curriculum at SMP Negeri 1 Siau Timur Selatan, was produced using the ADDIE model. The ADDIE model provides a clear and systematic framework that supports the development of complex educational products, making it highly suitable for instructional materials design (Ridha *et al*., as cited in Fadhila *et al*., 2022, p. 2). This model encompasses five stages: analysis, design, development, implementation, and evaluation. The first stage, analysis, includes a needs assessment involving both teachers and students, analysis of learning materials, and analysis of media requirements. This stage aims to identify learners' conditions and learning needs as the targeted users of the developed product.

Observations at SMP Negeri 1 Siau Timur Selatan indicated that students' scientific literacy in science subjects remains low. Students experience difficulties in connecting scientific content to real-life situations and struggle to draw independent conclusions during learning activities. The 2024 National Assessment also showed that students' literacy levels remain within the low category. Classroom observations further revealed that students' performance on tasks aligned with scientific literacy indicators understanding phenomena, identifying scientific problems, explaining phenomena, using scientific evidence, and internalizing scientific applications has not yet reached expected proficiency. These conditions highlight the need for an effective instructional model to improve scientific literacy. Although Problem-Based Learning (PBL) is one such model, interviews with Grade VIII science teachers confirmed that PBL has not been consistently implemented in teaching the human circulatory system.

Problem-Based Learning (PBL) has strong potential to help students develop open-minded, reflective, critical, creative, and active learning skills. By engaging students with authentic and contextually relevant problems, PBL encourages investigation, observation, and meaningful learning. As a student-centered model, PBL aims to guide learners in analyzing real-world cases that serve as triggers for developing appropriate problem-solving solutions. The problems used in PBL are directly sourced from everyday life (Paat & Mokalu, 2023) [14].

Interviews with the Grade VIII science teacher also revealed that the primary learning resource used in science instruction is the conventional printed LKPD. Observations further confirmed that E-LKPD has not been optimally utilized due to geographical constraints and limited technological infrastructure in the school. Internet access in the area is often unstable, and many students face difficulties participating in online learning because of inconsistent connectivity and limited internet quota. These challenges hinder the effective use of online digital learning media. Therefore, an offline E-LKPD is needed to ensure that students can access learning materials without relying on internet connectivity, while still engaging with content presented in an interactive, varied, and appealing format. The use of E-LKPD has been shown to support students in problem-solving and enhance their learning capabilities (Reisa, Latip, & Abdurrahman, 2024) [25].

The topic of the Human Circulatory System, part of the Grade VIII science curriculum, aims to help students understand scientific concepts through contextual problems and develop solutions related to circulatory system issues. It also supports awareness of healthy lifestyle practices. However, classroom observations revealed that students perceive this topic as difficult, primarily due to its abstract nature, limited instructional methods that encourage active learning, and a lack of student understanding regarding the relevance of the material. These factors reduce students' motivation to learn. Consequently, both an appropriate learning model and effective media are required to address these challenges. The use of an offline E-LKPD based on PBL is expected to help students solve contextual problems related to the human circulatory system—an essential component of scientific literacy.

Following the analysis phase, the design phase was conducted. This stage involved creating a storyboard and designing the product using Canva and Docfly, resulting in an offline E-LKPD distributed in PDF format. The developed product includes content on the human circulatory system for Grade VIII students. The development stage then followed, which involved expert validation by designated material and media specialists. Comments and suggestions provided by the experts served as the basis for revising and improving the product to ensure that it met the required standards for field testing. This process constitutes the development phase. The E-LKPD product underwent two rounds of material expert validation and three rounds of media expert validation.

6. Conclusions

Based on the development and evaluation of the Offline E-LKPD based on Problem-Based Learning for enhancing scientific literacy among Grade VIII students at SMP Negeri 1

Siau Timur Selatan on the Human Circulatory System topic, the following conclusions are drawn: The E-LKPD was developed using the ADDIE model, encompassing curriculum and needs analysis, material analysis, product design through storyboard development, expert validation, product trials, and continuous evaluation. The final product was created using Canva and DocFly and distributed in PDF format. The Offline E-LKPD was deemed feasible for instructional use. Material expert validation conducted twice produced a final score of 94% ("Excellent"), while media expert validation conducted three times yielded 97% ("Excellent"), indicating strong validity and readiness for implementation.

References

1. Chang CY, Kuo HC, Du Z. The role of digital literacy in augmented, virtual, and mixed reality in popular science education: a review study and an educational framework development. Virtual Reality. 2023;27(3):2461-79.
2. Darumba D, Lihiang A, Paat M, Mandolang A, Moko E, Rungkat JA. Developing an android-based interactive multimedia application for integrated science instruction at the junior high school level. J Adv Educ Sci. 2025;5(2):73-87.
3. Domits JM, Paat M, Rengkuan M, Tumbel FM, Lihiang A, Rungkat JA. Developing problem-based learning model integrated with Quizizz application to enhance science learning in SMP Pulau Bunaken, Indonesia. J Adv Educ Sci. 2025;5(2):47-57.
4. Giacumo LA, Breman J. Trends and implications of models, frameworks, and approaches used by instructional designers in workplace learning and performance improvement. Perform Improv Q. 2021;34(2):131-70.
5. Hamidah A, Ayunasari DS, Sanjaya E. Development of E-LKPD in motion system materials for high school class using pageflip 3D software. J Penelit Pendidik IPA. 2023;9(3):1233-41.
6. Kahar S, Tumbel F, Paat M. The effect of environmental learning models on science process skills and learning outcomes of students in SMP Negeri 10 Manado. Int J Acad Res Dev. 2020;5(4):34-8.
7. Kembuan G, Tumbel F, Paat M. Development of problem-based learning based student worksheets to improve student learning outcomes in Poigar 1 Public Middle School. Development. 2019;4(5):16-20.
8. Kindangen CR, Paat M, Suryani NW, Rungkat JA. Pengembangan multimedia interaktif menggunakan model problem based learning pada mata pelajaran IPA kelas VIII SMP Katolik Kembes. SOSCIED. 2023;6(2):361-72.
9. Kosakoy NV, Paat M, Tumbel FM. Developing a Canva-based blended learning model to improve science learning outcomes at SMP Negeri 4 Ratahan, Indonesia. J Adv Educ Sci. 2025;5(2):41-6.
10. Manein A, Paat M, Rampengan M. Model pembelajaran problem-based learning pada materi tumbuhan: penelitian tindakan kelas di SMA Negeri 1 Nanusa. J Riset Rumpun Ilmu Pendidik. 2025;4(1):352-70.
11. Mantiri FE, Lihiang A, Rengkuan M, Paat M, Rungkat JA. Generation Z perceptions of the problem-based learning approach in science instruction at SMP Negeri 2 Tondano and SMP Santa Rosa de Lima Tondano. J Adv Educ Sci. 2025;5(2):64-72.
12. Mokalu YB, Paat M, Lihiang A, Tumbel FM. Buku ajar IPA 3. Lakeisha, 2023.
13. Mokalu YB, Paat M, Polii IJ, Akbar JS, Kuron MA. Pengembangan model project-based learning berbasis pembuatan film untuk meningkatkan literasi mahasiswa pada mata kuliah Bahasa Indonesia Keilmuan. SOSCIED. 2024;7(2):760-9.
14. Mokalu YB, Paat M, Wowor EC, Tumewu WA, Kawuwung FR. Students' learning interest in the implementation of project-based learning models. SOSCIED. 2023;6(2):610-9.
15. Osborne J. Science, scientific literacy, and science education. In: Handbook of research on science education. Routledge, 2023, p785-816.
16. Paat M, Kawuwung FR, Mokalu YB. Penerapan LKS model pembelajaran berbasis masalah untuk meningkatkan kemampuan berpikir tingkat tinggi SMPN 5 Tondano. JISIP. 2021;5(2):469-76.
17. Paat M, Mokalu YB, Hadi Sutopo MMSI. Integrasi artificial intelligence dalam problem-based learning: pendekatan praktis. Topazart, 2024.
18. Paat M, Mokalu YB, Tumurang OM. Workshop pengembangan perangkat dengan model pembelajaran berbasis masalah untuk guru di Kecamatan Motoling Kabupaten Minahasa Selatan. Integritas J Pengabdian. 2024;8(1):129-40.
19. Paat M, Sompotan AF, Pesik A, Mokalu YB, Moroki I. Penerapan multimedia pembelajaran berbasis masalah dalam meningkatkan hasil belajar dan keterampilan berpikir tingkat tinggi. J Pendidik MIPA. 2024;14(1):155-62.
20. Paat M, Warouw ZWM, Mokalu YB. Developing an augmented reality-based learning tool for Gedi plant cultivation. J Mobile Multimedia. 2025;21(2):221-44.
21. Paat M, Mokalu YB. Development of web-blog-based learning media using problem-based learning model. SOSCIED. 2023;6(2):505-13.
22. Patibang RT, Paat M, Rungkat JA, Warouw ZWM, Rampengan MMF, Mokalu YB. Development of audio-visual learning media based on the CapCut application to enhance junior high school students' learning motivation. EDUPROXIMA. 2025;7(4):1824-35.
23. Pertiwi MG, Lihiang A, Paat M. Development of Animaker-based science learning multimedia on global warming materials at SMP Brother Don Bosco Tomohon. Web Semantic Univ J Innov Educ. 2023;2(6):166-74.
24. Rachmad SH, Muchammadun, Hakim L, Basorudin M, Risyanto R, Setram N. Empowering the disabled in Hajj pilgrimage: a sustainable approach for SDGs progress in Indonesia. J Disabil Relig. 2024;28(3):409-36.

25. Reisa, Latip A, Abdurrahman D. Development of E-LKPD based on problem-based learning. J Pendidik IPA, 2024, 1553.
26. Sain ZH, Aziz AL, Agoi MA. Navigating educational challenges in Indonesia: policy recommendations for future success. J Digit Learn Distance Educ. 2024;3(4):1038-46.
27. Sanudin TN, Paat M, Tumbel FM. Development of cooperative learning by utilizing circular design on the subject of energy at SMP Negeri 13 Manado. Int J Adv Educ Res. 2023;8(4):56-60.
28. Setiawan B, Suwandi E. The development of Indonesia national curriculum and its changes: the integrated science curriculum development in Indonesia. J Innov Educ Cult Res. 2022;3(4):528-35.
29. Siregar N, Sutopo H, Paat M. Mobile multimedia-based Batakologi learning model development. J Mobile Multimedia. 2019;15(4):271-88.
30. Sondakh RY, Tumbel FM, Paat M, Poluakan C. Developing android application-based interactive learning media with offline mode on excretion system materials. Int J Educ Res Dev. 2021;3(3):8-13.
31. Tumbel FM, Kawuwung FR, Paat M. Development of science learning tools using inquiry learning model to student learning outcomes. J Posit Sch Psychol, 2022, 6(6).