

Development of Live Worksheets Based on Problem-Based Learning to Improve Science Critical Thinking Skills

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Abstract: Optimizing the use of student worksheets in science learning is a strategic effort to improve the quality of the learning process and foster students' critical thinking skills. This study aims to describe the design, determine the feasibility, and examine the effectiveness of Live Worksheets based on Problem Based Learning in improving the critical thinking skills of fifth-grade students at SD Negeri Jatibarang 03 on the topic of the human respiratory system. This research employed a Research & Development (R&D) method using the ADDIE development model, which consists of analyze, design, development, implementation, and evaluation stages. The research subjects were 20 fifth-grade students. Data collection techniques included tests (pre-test and post-test) and non-test methods such as observation, interviews, questionnaires, and documentation. Data were analyzed qualitatively and quantitatively using normality tests, paired sample t-tests, and N-gain analysis. The Live Worksheets based on Problem-Based Learning were developed in Canva and accessed through the Live Worksheets platform. The product consists of a cover page, group identity page, general information page, core learning materials with problem-based questions, and a final page containing reinforcement materials and developer profiles. The feasibility results indicated very feasible criteria, with validation percentages of 92% from material experts and 94% from media experts, and positive responses from 90% of teachers and students. The effectiveness results showed a significant increase in scores from 47.5 to 71.25, a Sig. (2-tailed) value of $0.000 < 0.05$, a 22% improvement in critical thinking skills, and an N-gain of 0.4741 (moderate category). Thus, the Live Worksheets based on Problem-Based Learning were deemed successfully developed, feasible, and effective in improving students' critical thinking skills in science.

Keywords: Critical Thinking Skills; Live Worksheets; Problem-Based Learning; Science Learning.

Introduction

Science learning is the study of nature, closely related to human life, and plays a role in developing science and technology that can be applied in daily life. Natural Science (IPA) learning in elementary schools has a strategic position in developing scientific thinking skills. Science not only contains a collection of concepts, but also scientific processes that demand the ability to observe, interpret, analyze, and deduce natural phenomena [1]. Therefore, science learning needs to be designed so that students are actively involved in the investigation and problem-solving processes. In addition, the process of reflection and problem-based assignments is used to encourage students to apply the knowledge gained to daily life situations and practice critical thinking skills, so that learning becomes more meaningful [2].

The scope of science learning in elementary schools, according to the Educational Standards, Curriculum, and Assessment Agency (BSKAP) through the Ministry of Education Policy Number 046/H/KR/2025 concerning Learning Outcomes, stipulates that one of the scopes of science material phase C is the human organ system, including the respiratory system [3]. This material demands an in-depth understanding of the structure and function of the respiratory organs. In addition, students are also expected to understand the breathing mechanism of the chest and

abdomen as an interrelated system. This understanding cannot be obtained optimally by students if the learning is only through memorization. On the contrary, analytical skills are needed to study the relationships between organs and physiological processes that occur in daily life [4]. Therefore, learning strategies must be designed systematically and targeted. Therefore, contextual and process-based learning design is needed to build meaningful understanding in learning activities.

Critical thinking skills are the ability to analyze information in depth, evaluate arguments, and make decisions based on logical evidence [5]. Critical thinking skills consist of 5 indicators, including (1) providing simple explanations; (2) using the information appropriately; (3) conclude; (4) provides in depth explanation; and (5) determining problem-solving strategies [6]. Critical thinking skills need to be trained systematically through structured learning activities. Teachers can apply various learning strategies to make the teaching and learning process more interesting and varied, through the selection of materials, the application of models, the use of media, and various methods [7]. This effort aims to make science learning more meaningful so that students can understand concepts better and apply them in daily life. Thus, it requires the right learning tools.

The student worksheet is one of the tools that can facilitate independent and collaborative learning activities. A

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well-designed student worksheet not only includes practice questions but also problem stimuli, work steps, and reflections that encourage students to think analytically [8]. The ideal student worksheets component meets title, learning instructions, competencies or learning objectives, supporting information, tasks or work steps, and assessments [9]. Student worksheets in science learning can be designed according to the material studied and direct learning activities to scientific processes such as analyzing, solving problems, evaluating, conducting experiments, making hypotheses and making conclusions [10]. Each activity in the student worksheets is designed to spark questions, encourage exploration, and provide students with space to build knowledge independently and collaboratively [11]. The development of digital technology opens up opportunities to transform student worksheets into electronic form.

Electronic student worksheets are used as a learning tool to help students understand the material through digital activities. Electronic -student worksheets enable the integration of text, images, videos, and automated feedback, creating a more interactive and flexible learning experience [12]. One platform for developing Live Worksheets. The platform provides a variety of features such as multiple selection, drag and drop, open answer, and visual and audiovisual media integration [13]. These features allow students to be actively involved in the learning process. To be pedagogically effective rather than merely technically interactive, its development needs to be combined with appropriate learning models.

The Problem-Based Learning model is a problem-based learning model. Models Problem-Based Learning, placing contextual problems as the starting point of learning and encouraging students to investigate to find solutions [14]. The syntax of Problem-Based Learning includes the following 1) orienting students to problems, 2) organizing students to learn, 3) guiding investigations, 4) developing and presenting results, and 5) analyzing and evaluating the problem-solving process [15]. The integration of PBL into electronic students' worksheets provides an opportunity to comprehensively train critical thinking indicators. Students' critical thinking skills can be developed in the classroom by stimulating and facilitating students through problem-based learning [16]. Students are directed to formulate problems, give reasons based on observations, draw logical conclusions, and evaluate the solutions produced. Thus, science learning is not only oriented toward the final result but also toward a systematic and reflective thinking process.

Based on the results of the pre-research in grade V of SD Negeri Jatibarang 03, teachers have not optimized the preparation of student worksheets because they are still conventional, without stimuli that encourage exploration and development of critical thinking. Important components of student worksheets, such as learning instructions, learning objectives, and assessment and reflection, have not been met. The presentation is still in the form of black and white print, making it less attractive and less effective in the digital era [17]. This condition makes students less directed and passive, and not able to explore concepts independently. Student worksheets have not trained critical thinking optimally because they only contain C3 level questions (apply and sort), while indicators C4 (analyzing) and C5 (evaluating) have not been facilitated. The question instructions also do not encourage logical reasoning and in-

depth analysis, so the answers do not reflect critical thinking skills.

In learning, teachers have not optimally applied the five syntax Problem-Based Learning Overall, so that students tend to be passive, and learning is still dominated by lecture methods. Interaction between teachers and students, as well as among students, remains limited. Conventional learning makes students less active and less likely to explore concepts independently [18]. In the first syntax, the teacher has not presented contextual problems, stimuli, or introductions that trigger critical thinking. In the second syntax, the organization of students into groups for student worksheets has not run optimally because students listen to videos without taking notes, so their understanding of the material is not optimal when working on the questions. In the third syntax, teachers have not optimally guided investigations by providing supporting teaching materials such as presentation media or problem-based student worksheets. As a result, the implementation of PBL has been ineffective and has affected student learning outcomes.

The summative learning results for grade V students of SD Negeri Jatibarang 03 in science learning, within the scope of material 1, showed that some students had not met the KKTP 70. Of the 20 students, 32% have met the KKTP, while 68% have not. This shows that there are still obstacles in understanding science material in the classroom. This low learning outcome is often caused by the use of learning methods that are still conventional, tend to be one-way, and do not actively involve students in the learning process [19].

60% of the 20 students who have not met the KKTP have not developed their critical thinking skills. Students are not accustomed to being trained to analyze, give reasons, and solve problems when completing student worksheets and evaluations in science. The low critical thinking ability is evident in the students' short, unreasoned answers to the analysis questions. The student's inability to give a logical reason for his opinion is one of the indicators of evaluating the cognitive level C5 [20].

Students have difficulty understanding the science material on the human respiratory system. Students have difficulty understanding the material of the human respiratory system, including the names and functions of organs, foreign terms, and the breathing mechanisms of the chest and abdomen. The ability to think critically is also not optimal, as can be seen from the difficulty of analyzing differences in air quality, the working relationship of respiratory organs, and the effect of physical activity on breathing frequency. The failure to achieve learning objectives and unsatisfactory learning outcomes show that students' understanding of learning materials is still relatively low [21].

Based on previous research entitled Development of Electronic Student Worksheets Based on Problem-Based Learning (PBL) to Improve Students' Critical Thinking Skills in the Food Sub-Material. Practicality, based on student responses, scored 97.07% of the criteria as very practical, supported by the results of observations of student activities, with 98.6% of the criteria scored as very good. Based on this research, electronic student worksheets are based on Problem-Based Learning, which has been developed and proven to be valid, practical, effective in its application as a teaching material, and able to improve students' critical thinking skills [22]. However, previous

research has not specifically integrated Live Worksheets and has not measured critical thinking skills using structured, statistically analyzed indicators. Thus, the novelty of this research lies in the systematic application of five syntax Problem-Based Learning activities in Live Worksheets, which facilitate critical thinking skills. Thus, this study not only demonstrates the product's feasibility and practicality but also tests its effectiveness in improving students' critical thinking skills in a measurable manner.

These problems highlight the need for learning device innovations that integrate digital technology and problem-based learning models. Therefore, the researcher developed of Live Worksheets based on Problem Based Learning to improve the critical thinking skills of science students in grade V of SD Negeri Jatibarang 03 Semarang City with the aim of: (1) describing the development design of Live Worksheets based on Problem Based Learning to improve the critical thinking skills of science students in grade V of SD Negeri Jatibarang 03 Semarang City; (2) testing the feasibility of Live Worksheets based on Problem Based Learning to improve the science critical thinking skills of grade V students of SD Negeri Jatibarang 03 Semarang City; and (3) testing the effectiveness the feasibility of Live Worksheets based on Problem Based Learning to improve the science critical thinking skills of grade V students of SD Negeri Jatibarang 03 Semarang City. This research is expected to make a conceptual and practical contribution to the development of digital learning tools that support the optimal implementation of the Deep Learning Curriculum.

Research Methods

This type of research is Research & Development (R&D) with the ADDIE model. Research & development is a process or steps in research to validate and develop products [23]. The procedure or stages of developing the ADDIE model are described as follows.

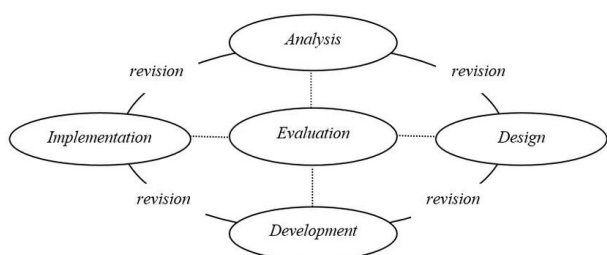


Figure 1. Stages of the ADDIE model (Sugiyono, 2023)

ADDIE's development model consists of five stages, namely (1) Analyze, (2) Design, (3) development, (4) implementation, and (5) evaluation [23]. (1) Stage Analyze (analysis), identification of learning problems, potentials, and needs through classroom observation, teacher interviews, and the distribution of questionnaires to students and teachers; (2) Stage Design (design), the researcher designed a prototype of the Live Worksheets based Problem Based Learning according to the learning needs; (3) Stage development (development) is the process of realizing a design into a product that is ready to be tested through the platform Live Worksheets. Then it is validated by material experts and media experts to determine the feasibility and obtain input before the trial; (4) Stage implementation (implementation) was carried out through small-scale trials

of 8 students and large-scale trials of 12 students; (5) Stage evaluation (evaluation) aims to assess the quality, feasibility, and effectiveness of the developed product. The evaluation was carried out through the analysis of pre-test and post-test results to measure improvements in students' critical thinking skills in the cognitive domain, as well as through a questionnaire with teacher and student responses.

This research was conducted at SD Negeri Jatibarang 03, Semarang City, during the even semester of the 2025/2026 school year. The study involved class V students, totalling 20. Classroom teachers are also involved as partners in the implementation of learning and as informants in the analysis and feasibility test stages through teacher response questionnaires. Data collection techniques using tests (pre-test and post-test) and non-tests (observations, interviews, questionnaires and document data) [24]. Data analysis techniques are carried out qualitatively and quantitatively. Qualitative data is analyzed through data reduction, data presentation, and drawing conclusions based on the results of observations, interviews, and validator suggestions. Quantitative data were analyzed using normality tests, paired-samples t-tests, and N-Gain tests to assess the effectiveness of Live Worksheets-based Problem-Based Learning.

Results and Discussion

This research focuses on the design, development, feasibility, and effectiveness of Live Worksheets based on Problem-Based Learning to improve the science critical thinking skills of grade V students at SD Negeri Jatibarang 03, Semarang City.

Development Design of Live Worksheets based on Problem-Based Learning

This study uses the development of the ADDIE model, which includes five stages, namely (1) Analyze, (2) Design, (3) development, (4) implementation, and (5) evaluation. The results of the research in this section are presented based on the process and findings obtained at each of these stages.

Analyze

At this stage, the researcher analyzes the identification of learning problems, potentials, and needs through classroom observation, teacher interviews, and the distribution of questionnaires to students and teachers. The results of problem identification in the preparation of students' worksheets remain conventional and lack important components such as learning instructions, learning objectives, contextual problem stimuli, and reflection and assessment. Conventional methods tend to make students passive and offer fewer opportunities to discover concepts independently [18]. In addition, the cognitive level of the questions in students' worksheets is still at C3 (applying), not facilitating C4 (analyzing) and C5 (evaluating). The low facilitation of HOTS questions affects learning outcomes, as most students have not reached the KKTP and have not been able to provide logical reasons in their answers to analytical questions. Thus, the problem does not lie solely in the media

but also in the learning model and the measurement of critical thinking skills.

SD Negeri Jatibarang 03 has strong potential to support the implementation of technology-based learning. This school has been equipped with adequate facilities to support teaching and learning. Projector, loudspeaker, and access to Wi-Fi, which supports internet-based learning activities. SD Negeri Jatibarang 03 also allows students to use gadgets to support learning. The use of this gadget is used to find information or learning resources, as well as to facilitate technology-based learning media [25]. The analysis of needs through student questionnaires reveals aspects of interest and motivation, participation, and the roles of teachers, models, and media. The questionnaire needs to cover aspects of learning planning and assessment, as well as learning outcome achievement and critical thinking skills.

Based on this identification, a solution is needed: the development of student worksheets that are more systematic, contextual, and oriented toward the development of critical thinking skills. The components of an ideal student's worksheets consist of a title, learning instructions, competencies or learning objectives, supporting information, tasks or work steps, and assessments [26]. A good student's worksheet must support the active learning process and encourage students to think about problem-solving [27]. As technology advances, students' worksheets need to be digitised to make them more interactive and engaging. Printed students' worksheets are considered less effective and less visually appealing, especially at the elementary school level [17].

Electronic students' worksheets are able to create a fun and interactive learning atmosphere because they dynamically combine visual and contextual content [28]. On the Live Worksheets platform, teachers can design interactive worksheets that include text, images, videos, and audio. These features support a variety of learning styles and enable students to have a more meaningful learning experience [29]. Electronic students' worksheets serve not only as a digital medium but also as a means to develop high-level thinking skills; their design should be problem-based and integrated with the Problem-Based Learning model.

Problem-based learning is a student-centred learning model in which students encounter real problems in daily life during learning activities. The focus of learning in the PBL model lies in the problems students must solve using appropriate material concepts. Models Problem-Based Learning emphasizing learning through contextual problems that require students to think critically, analyze information, and work together to find solutions [30]. Syntax Problem-Based Learning, i.e. 1) orientation students to problems, 2) organizing students to learn, 3) guiding investigations, 4) developing and presenting results, and 5) analyzing and evaluating the problem-solving process [31].

Capabilities: Critical thinking is the ability to analyze and evaluate information, understand arguments, and draw conclusions based on existing evidence [32]. Critical thinking skills then need to be measured using clear and structured indicators, especially at the C4 (analyzing) and C5 (evaluating) levels. Critical thinking skills have 5 indicators with 8 sub-indicators consisting of: (1) providing simple explanations, which include the ability of students to determine questions that are in accordance with the problem presented as well as explaining answers to questions that

need explanation; (2) using information appropriately, namely the ability to observe and utilize observation data as a basis for solving problems; (3) inferring, which includes the ability to analyze general statements into specific facts based on cause-and-effect relationships and relate those facts to a common conclusion; (4) provide an in-depth explanation, namely the ability to assess the accuracy of the definition based on the available criteria or information and prove the truth of unwritten conjectures or assumptions directly through drawing conclusions; and (5) determining a problem-solving strategy, namely the ability to decide whether to agree or disagree with a statement accompanied by logical reasons [33]. Based on the description of the analyze stage, it emphasizes the need to develop Live Worksheets based on Problem-Based Learning to improve the critical thinking skills of science students in grade V of SD Negeri Jatibarang 03.

Design

Stage design is a step in the preparation of the product design to be developed, along with its specifications [34]. At this stage, the researcher uses the Canva application to design the appearance of the Live Worksheets-based Problem-Based Learning to make it more attractive. Canva is used to design each Live Worksheets-based Problem-Based Learning page, including background and text color selection, font size and type, and electronic student worksheet components. Live Worksheets-based Problem-Based Learning was developed using the Live Worksheets platform. Live Worksheets-based Problem-Based Learning uses a variety of features from Live Worksheets, such as live worksheets features which include open answer, single choice, drag and drop, join, PowerPoint player and YouTube player [35].

These Live Worksheets-based Problem-Based Learning adopt a Problem-Based Learning model that is adjusted to the learning model applied during the learning process. Preparation of Live Worksheets based Problem Based Learning is carried out by systematically arranging components, consisting of pages Cover (cover) containing the title, class, logo, illustration, and identity of the author; group identity for students, general information containing learning outcomes, learning objectives, and instructions for working on Live Worksheets based Problem Based Learning; the core page in the form of learning materials and problem-based questions designed to train students' critical thinking skills; and the last page of Live Worksheets based Problem Based Learning realized in two meetings. On Live Worksheets, based on Problem-Based Learning in lesson 1, the material focuses on the human respiratory organ and its function. Therefore, the activities and questions presented are designed to help students recognize the names of respiratory organs and understand the function of each organ in the respiratory system. Meanwhile, Live Worksheets based on Problem-Based Learning in lesson 2 focus on the human breathing mechanism, which is the process of how humans breathe. This material covers the process of inspiration and expiration, diaphragm movements, changes in the volume of the chest cavity, and the differences between chest breathing and abdominal breathing [36]. The following is the design of Live Worksheets based on Problem-Based Learning for lessons 1 and 2.

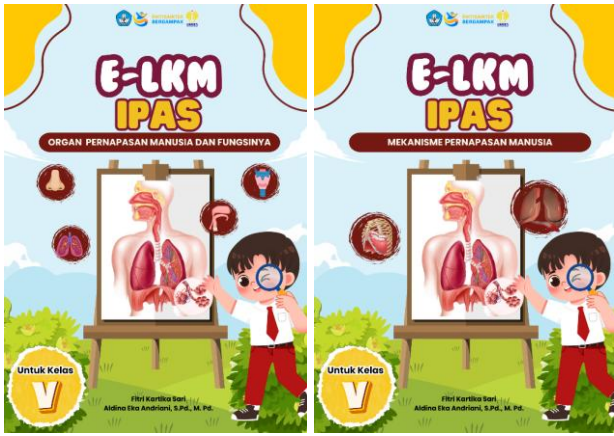


Figure 2. Cover of Live Worksheets based on Problem-Based Learning in Lessons 1 and 2

The illustration of the respiratory system on the cover serves as an initial introduction, giving students an idea of the material they will study. The selection of semi-concrete images and colors helps students understand abstract concepts, clarify the location and function of the organs. Images related to learning materials serve to convey messages from teachers to students, help them express information more clearly, and motivate them to follow the learning process [37].



Figure 3. General Information: Live Worksheets, Problem-Based Learning 1 and 2

The General Information section on the Live Worksheets-based Problem-Based Learning page, which contains learning outcomes, learning objectives, and work instructions, serves as an initial guide for students to understand the direction of learning activities. Clearly written learning outcomes and objectives help students know the results to be achieved, so that they not only do the task, but are truly focused, understand the expected competencies and are motivated to learn [38]. Meanwhile, the instructions provide students with a brief overview of the form of learning activities using Live Worksheets based on Problem-Based Learning.

In Syntax 1, the Live Worksheets-based Problem-Based Learning lesson 1 displays a video on air entering the nose and mouth. This video helps students compare air entry paths and understand their different functions. Meanwhile, the Live Worksheets-based Problem-Based Learning lesson 2 also included two videos showing people breathing, with abdominal and chest movements, so students could observe the difference between chest and abdominal breathing directly. The use of stimuli in the form of videos stimulates attention and positive emotions during the learning process and provides a more contextual learning experience [39]. The questions on Live Worksheets based on Problem-Based Learning 1 and 2 are designed to facilitate critical thinking skills in the first indicator, which is to provide a simple explanation based on observations, and the second indicator, which is to use information appropriately to answer questions according to the evidence obtained from the video.



Figure 5. Syntax View 2 PBL Model

In syntax 2, there is a brief piece of information: "Did you know?" This initial information serves as a cognitive bridge, focusing the student's attention before they formulate a problem-solving solution. In addition, students are invited to formulate temporary conjectures or hypotheses by selecting the most appropriate statements. The process of compiling these allegations is facilitated interactively through the use of a checkbox (check) on the platform Live Worksheets. The activity of selecting and considering the truth of this information effectively trains critical thinking skills in analyzing and evaluating [40]. Instructions for the work are also included in syntax 2 to provide directions for Live Worksheets-based Problem-Based Learning in groups.

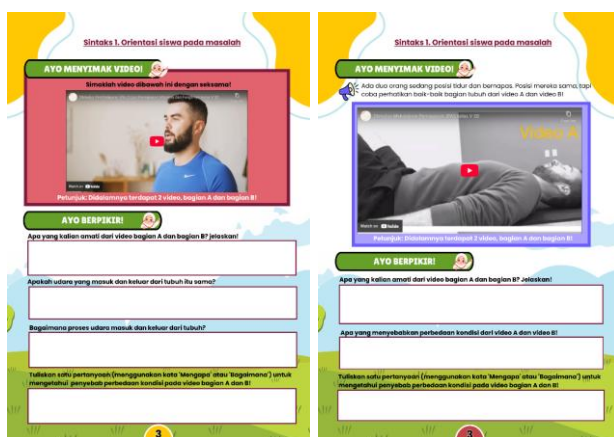


Figure 4. Syntax View 1 PBL Model

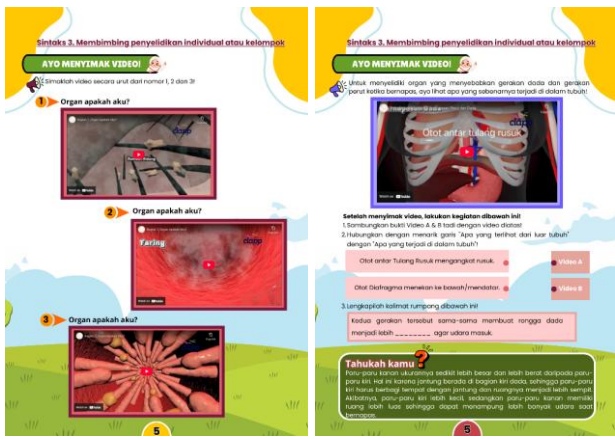


Figure 6. Syntax View 3 PBL Model

In syntax 3, it guides the investigation by collecting information through videos that facilitate the appropriate use of indicators. In the Live Worksheets-based Problem-Based Learning lesson 1, variations for solving problems are also presented in the form of contextual short stories, which direct students to analyse the respiratory organs and their functions. Meanwhile, in Live Worksheets-based Problem-Based Learning lesson 2, the problem-solving strategy is complemented by simple practicum activities in the form of making concrete media of lung models, with the work steps listed in the Live Worksheets-based Problem-Based Learning, which can help students in visualizing concepts in real life [41].

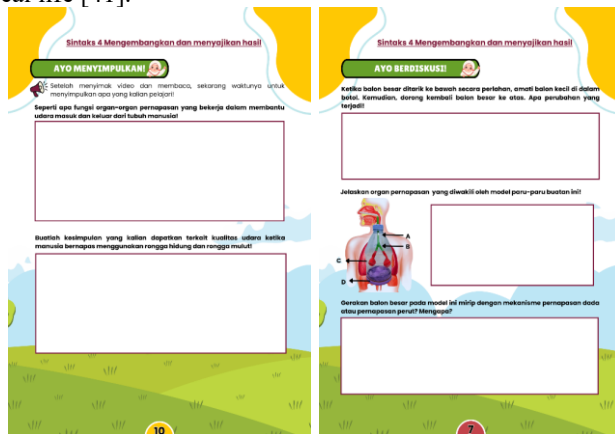


Figure 7. Syntax View of 4 PBL Models

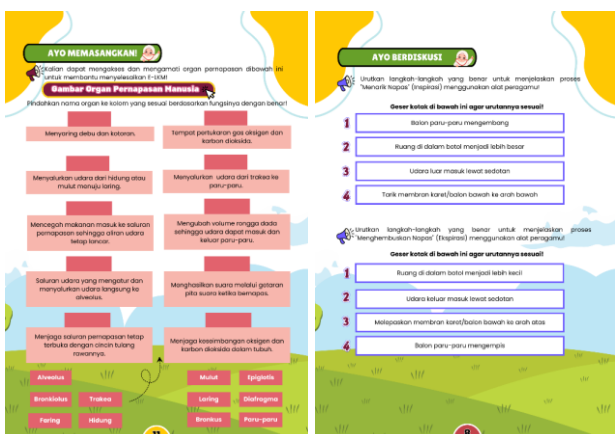


Figure 8. Live Worksheets Feature Utilization View

Students are directed to conclude all the results of the research carried out from syntax 1 to syntax 3. This concluding activity was facilitated through instructions for filling in descriptive answers, adjusted to the material on the respiratory system. Writing conclusions in the form of text helps students express the results of their analysis in a coherent manner and strengthens their understanding of the concepts that have been learned [42]. Concluding activities facilitate critical thinking skills, especially when they include concluding indicators and in-depth explanations.

For variety, before the fifth syntax, each Live Worksheet-based Problem-Based Learning utilizes Live Worksheets in the form of educational games to vary the learning activities. In Live Worksheets-based Problem-Based Learning lesson 1, students carry out matching activities using drag-and-drop, while in Live Worksheets-based Problem-Based Learning lesson 2, students sequence the stages of the breathing mechanism using drag-and-drop. This variation aims for students to not only type answers, but also actively engage through interactive activities that support understanding in learning [43].



Figure 9. Syntax View of 5 PBL Models

Live Worksheets based on Problem-Based Learning provide reinforcement materials to help students correct misconceptions and ensure that students' understanding is correct. This material is presented in PowerPoint, accessible via the link in Live Worksheets, based on Problem-Based Learning. Especially in the Live worksheets based on the Problem-Based Learning lesson 2, an animated video was added to help students more easily understand the dynamic breathing process. The combination of text, images, and animations helps to make it easier to understand and reduce the cognitive load on students when learning complex concepts [44].

Development

Stage development is the process of realizing the Live Worksheets based on Problem-Based Learning design into a form of a prototype testable [45]. At the Development stage, the product was integrated into the Live Worksheets platform, and a feasibility test was conducted by material and media experts. The results of the feasibility test, as validated by media and materials experts, met the very feasible criteria with revision. Aspects of material expert validation include: (1) aspects of material suitability with CP and TP; (2)

aspects of conformity with the PBL model; (3) aspects of conformity with the indicators of critical thinking ability; (4) aspects of conformity with the characteristics of students. The validation aspects of media experts include: (1) aspects of content quality and display; (2) instructional aspects; (3) technical/display aspects; (4) aspects of critical thinking ability.

Implementation

At the stage of implementation, development products that have been declared feasible by material experts and media experts are then tested by students [46]. The trial was carried out on students whose class level was one level higher than the research subject. The researcher administered a test of questions to class VI students (26 students). The results of the test scores will be analyzed for validity tests, reliability tests, question difficulty level tests, and question differentiating power tests [47]. Of the 40 questions, 20 were deemed valid and reliable. With difficult, medium and easy difficulty levels. The distinguishing power of classified questions is very good, good, adequate, and not good. The question items that were declared valid and reliable represented five indicators of critical thinking ability. The indicators provide simple explanations in numbers 7 and 15, use the information correctly on numbers 5, 18, and 20, conclude on numbers 1, 2, 4, 8, 11, and 19, provide in-depth explanations on numbers 12, 14, and 17, and determine problem-solving strategies on numbers 3, 6, 9, 10, 13, and 16. Thus, all indicators have been represented proportionally, making the instrument suitable for measuring students' critical thinking skills as a pretest and posttest in research.

Evaluation

At this stage, the evaluation aims to assess the quality, feasibility, and effectiveness of products, live worksheets based on Problem-Based Learning and ensure that development goals have been achieved [45]. In addition, product feasibility tests were conducted using teacher and student response questionnaires to assess the feasibility of Live worksheets based on Problem-Based Learning. At the evaluation stage, after obtaining the results of the pre-test and post-test, the normality test data was analyzed, the test paired sample t-test, and the N- testGain [48].

Feasibility of Live Worksheets based on Problem-Based Learning

The feasibility of Live Worksheets based on Problem-Based Learning was tested through validation by material experts, validation by media experts, and responses from teachers and students.

Table 1. Results of the Validation Feasibility Test for Subject Matter Experts and Media Experts

Response	Percentage	Criteria
Material Expert	92%	Highly Worth It
Media Member	94%	Highly Worth It

Based on Table 1. The validation results show that the product received very good scores from both validators. The

results of the material expert's validation obtained a score of 92% with very feasible criteria. The assessment of the feasibility of material validation using a research instrument questionnaire uses 4 aspects, including: (1) aspects of material suitability with CP and TP; (2) aspects of conformity with the PBL model; (3) aspects of conformity with the indicators of critical thinking ability; (4) aspects of conformity with the characteristics of students. The score shows that Live Worksheets are based on Problem-Based Learning, are complete, correct, and in accordance with the Learning Outcomes (CP) and Learning Objectives (TP) in the curriculum. The material has also been adjusted to the thinking level of elementary school students, making it easy to understand. Integrating Problem-Based Learning (PBL) syntax that is in line with the critical thinking ability indicators is considered very important, because it can guide students to solve real problems in a coherent and logical manner [49]. The media experts' validation yielded a score of 94%, which is very good. The assessment of the feasibility of material validation using a research instrument questionnaire uses 4 aspects, including: (1) aspects of content quality and display; (2) instructional aspects; (3) technical/display aspects; (4) aspects of critical thinking ability. The acquisition of a media validation score indicates that the design of Live Worksheets based on Problem-Based Learning is very good, both in terms of appearance, ease of use, and its function in supporting learning. The neat layout and accessible features make students more comfortable while studying. The use of interactive platforms with attractive displays has also been proven to increase learning comfort and help reduce the burden of thinking, so that students can focus more on answering questions that practice critical thinking [50].

Table 2. Teacher and Student Response

Response	Percentage	Criteria
Teacher	90%	Highly Worth It
Student	90%	Highly Worth It

Based on Table 2. The results of the response of teachers and students both obtained a percentage of 90% with very feasible criteria, so that Live Worksheets based on Problem-Based Learning declared suitable for use in science learning class V. Assessment of the feasibility of the teacher's response questionnaire uses 3 aspects which include: (1) suitability with the learning material; (2) conformity with PBL syntax and critical thinking ability; (3) appearance and practicality of use. The results of the teacher's response indicate that the Live Worksheets-based Problem-Based Learning is pedagogically feasible and aligned with classroom learning needs. The teacher assessed that the content and activities were in harmony with the science material in class V, making it easy to apply in the teaching and learning process. The integration of Problem-Based Learning (PBL) syntax into Live Worksheets is also considered to train indicators of critical thinking skills in a practical way, without adding administrative tasks or technical obstacles for teachers during teaching [51]. The assessment of the eligibility of the student response questionnaire uses 3 aspects, which include: (1) cognitive (comprehension); (2) affective (interests and attitudes); (3) practicality of use. In line with the constructivist theory, Live worksheets based on Problem-Based Learning provide

opportunities for students to build their own understanding through problem-solving activities. They help to accommodate a variety of learning styles, both visual, auditory, and kinesthetic, to improve accessibility and provide more inclusive learning opportunities for all students [52]. Based on this description of Live worksheets, Problem-Based Learning to improve critical thinking skills, and the suitability of science for learning, this is suitable for use in learning.

The Effectiveness of Live Worksheets based on Problem-Based Learning

The effectiveness of Live Worksheets based on Problem-Based Learning was evaluated using normality tests, paired-samples t-tests, and N-gain tests in SPSS 31. The results of the pre-test and post-test were then analyzed to determine the improvement of learning outcomes and the development of critical thinking skills in each indicator.

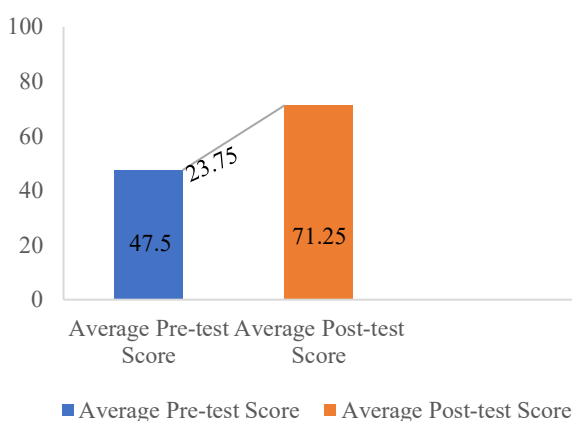


Figure 10. Average Improvement of Pre-test and Post-test Results

Based on the pre-test and post-test results, the post-test score is higher than the pre-test score. The average pre-test score was 47.5, while the average post-test score increased to 71.25. Thus, there was an increase of 23.75 in the average pre-test and post-test results. This increase shows that Live Worksheets-based Problem-Based Learning has a positive impact on students' cognitive development. One of the factors influencing this increase is the syntax characteristics of PBL itself, since from the beginning of learning, students are directly exposed to problem-solving skills and digging up new information [53].

Table 3. Normality Test Results

Actions	Sig	Criteria
Pre-test	0.331	Normal
Post-test	0.869	Normal

The normality test of learning outcomes is carried out as a preliminary requirement before analyzing data with nonparametric statistics [54]. The table above presents the results of the normality test of pre-test and post-test data in the initial trial analyzed using the SPSS 31 application. Based on the results of the normality test using the Shapiro-Wilk method, the pre-test significance value was 0.331, and the post-test significance value was 0.869. The results of the analysis showed that the pre-test significance value was 0.331 (> 0.05), indicating that the pre-test data were

normally distributed. Similarly, in the post-test, the significance value was 0.869, which was > 0.05, so the post-test data were also normally distributed.

Table 4. Paired Sample t-test results

Actions	Mean	Improvement	Sig.(2-tailed)
Pre-test	47.5	23.75	0.000
Post-test	71.25		

Based on the results of the paired-samples t-test, the average pre-test score in the large-scale trial is 47.5, and the average post-test score is 71.25. Thus, there was an average increase of 23.75 after learning using Live Worksheets based on Problem-Based Learning. The significance value of Sig. (2-tailed) is 0.000 < 0.05, thus indicating a significant difference between the two variables [55]. Based on the decision-making criteria, if the significance value < 0.05, then H_0 is rejected and H_a is accepted. So, it can be concluded that there is a significant difference in the science critical thinking ability of grade V students at SD Negeri Jatibarang 03 after using the Live Worksheets development based on Problem-Based Learning.

Table 5. N-Gain Test Results

Actions	Mean	Improvement	N-Gain	Criteria
Pre-test	47.5	23.75	0.4741	Medium
Post-test	71.25			

The average improvement in student learning outcomes before and after using Live Worksheets based on Problem-Based Learning to enhance the critical thinking skills of grade V science students at SD Negeri Jatibarang 03, Semarang City, was measured using an N-gain test. The results of the large-scale N-gain test were 0.4741, meeting the medium criteria. The increase in N-gain was in the moderate criterion with a range of $0.30 < N\text{-gain} < 0.70$ [34]. The increase in this moderate criterion is influenced by several supporting factors. First, the application of PBL syntax encourages students to actively solve problems, discuss, and draw conclusions, thereby systematically training critical thinking indicators. Second, the use of features in Live Worksheets, such as open answer, drag and drop, and Learning videos, helps pupils understand concepts visually and contextually [56]. Third, the existence of simple experiments and problem-based stimuli makes learning more meaningful and increases student engagement.

Another factor is that students' initial ability is still low, causing them to need time to adapt to the PBL model and the use of digital media. In addition, limited learning time, student experience and motivation that are not familiar with high-level thinking questions (HOTS) can affect the optimization of critical thinking skills [57]. In line with the findings that electronic students' worksheets that adopt the PBL model improve critical thinking skills [58]. This indicates that students' critical thinking skills improved after participating in learning using Live Worksheets based on Problem-Based Learning, compared to before the learning was implemented. Thus, it can be concluded that Live Worksheets based on Problem-Based Learning are effective in improving the critical thinking skills of grade V science students at SD Negeri Jatibarang 03, Semarang City.

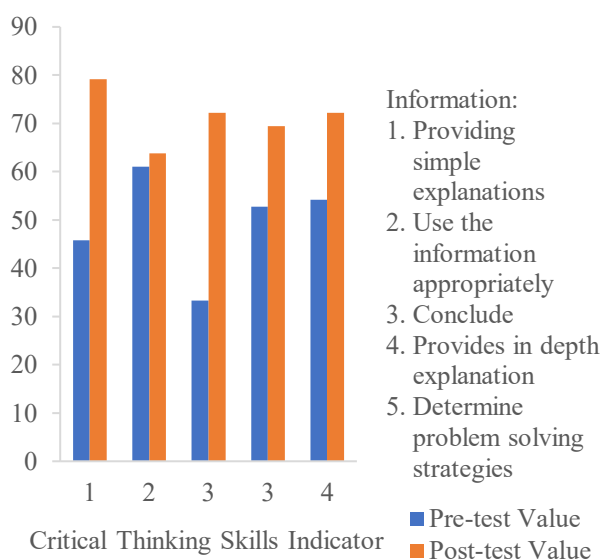


Figure 11. Increase in Average Critical Thinking Skill Score

The increase in students' critical thinking skills as shown by the increase in pre-test to post-test results, was analyzed based on 5 indicators include (1) providing a simple explanation; (2) use the information appropriately; (3) conclude; (4) provides in depth explanation; and (5) determine problem-solving strategies [59]. The average increase across all indicators was from 49.4 to 71.4, representing a 22% increase. The increase in each indicator is outlined as follows.

The indicator provided a simple explanation, showing an increase from 45.83 to 79.16. It also shows that students' ability to determine appropriate questions based on the problem presented and to explain answers to questions that require explanation increased by 33.3%. This increase shows that students are sufficiently accustomed to identifying problems or information in a fundamental way. The indicator provides a simple explanation of cognitive level C2 (understanding), which is classified as a MOTS problem, so students are accustomed to solving it. This habit reflects the importance of assessing critical thinking skills, since through this process, the teacher can observe the extent to which the student understands the initial information needed as a basis for further analysis. [61].

The indicator uses information appropriately from a score of 61 to 63.8. In the section on using information correctly, the percentage increase was the smallest, which was only 2.8%. The low increase can be caused by students not being accustomed to doing critical thinking activities, such as formulating appropriate questions, sorting out relevant information, analyzing information, and evaluating the correctness of information [62]. In addition, these results are also influenced by the proportion of correct and incorrect answers on the relatively balanced indicator, so that the increase in scores does not show significant changes. This condition indicates the need for continuous habituation and practice so that students are more skilled in choosing and using information appropriately.

The indicator showed an increase from 33.3 to 72.2. Meanwhile, the student's ability to infer showed the highest

percentage increase of 38.9%. Concluding indicators are shown through the ability to draw precise conclusions from the data that has been obtained [63]. In indicators that have a high increase, that is, concluding. This happens because students already understand similar types of questions through problem-solving presented in Live Worksheets, based on Problem-Based Learning.

The indicator provides an in-depth explanation of the increase from 52.7 to 69.4. To provide an in-depth explanation, the percentage increase was 16.7%. This increase shows students' ability to provide more detailed, structured answers. However, the relatively lower percentage increase compared to other indicators indicates that the ability to provide in-depth explanations still needs to be strengthened. This is because students are used to giving answers based on estimates without explanations or strong reasons, which shows a weak conceptual understanding. Students only partially understand the information and are not able to relate the relevant concepts thoroughly [64].

The indicator measuring the problem-solving strategy increased from 54.16 to 72.2. The ability to determine problem-solving strategies also increased by 18.04%. This increase shows the development of students' ability to design more targeted problem-solving measures after using Live Worksheets-based Problem-Based Learning. So as to provide opportunities for students to develop their knowledge in a more complex way through collaboration in developing problem-solving strategies [65]. However, this is not used in problem-based learning, so students still experience confusion when deciding whether to agree or disagree with a statement, due to the lack of a logical reason and to time constraints that make the strategy-formulation process suboptimal.

Based on the description of the results of the analysis of the average increase in pre-test and post-test, normality test, paired sample t-test, N-gain test, and analysis of the average increase in critical thinking ability scores, it shows that the development of Live Worksheets based on Problem Based Learning is effective in improving the critical thinking skills of science students in grade V of SD N Jatibarang 03 Semarang City.

Conclusion

The development of Live Worksheets based on Problem-Based Learning for grade V students of SD Negeri Jatibarang 03, Semarang City, was designed in Canva and accessed via Live Worksheets, integrating five Problem-Based Learning syntaxes in each learning activity to facilitate critical thinking skills. The validation results showed that the product was very suitable for use, with 92% from material experts, 94% from media experts, and 90% from teachers and students. The product's effectiveness was demonstrated by an average increase in critical thinking ability of 22%, with an N-Gain value of 0.4741 at the moderate criterion. These findings show that Live Worksheets based on Problem Based Learning have been successfully developed, feasible, and effective in improving critical thinking skills Although still limited to the material of the human respiratory system and the use of certain features, this development has a positive impact on learning by encouraging active engagement, logical analysis, and problem solving, so that the application of Problem Based

Learning consistently recommended to improve the quality of science learning on an ongoing basis.

Author's Contribution

F.K. Sari: contributing to research, product development, data analysis, and research writing; A.E. Andriani: contributing to compiling, guiding, and revising research.

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References

- [1] A. Latip, "Pembelajaran IPA berorientasi pada frameworkstrategic vision and direction for science (SVDS) PISA 2024," *JKPI J. Kaji. Pendidik. IPA*, vol. 4, no. 1, pp. 305–314, 2024, [Online]. Available: <https://doi.org/10.52434/jkpi13579>
- [2] Nurpaissa and E. Rustan, "Strategi Guru dalam Meningkatkan Kemampuan Berpikir Kritis Siswa di SDN 21 Tadette : Analisis Faktor Pendukung dan Penghambat Pendahuluan Metode," *Al Birru J. Ilm. Bid. Pendidik. Dasar*, vol. 2, no. 2, pp. 27–32, 2024, [Online]. Available: <https://ssed.or.id/journal/albirru/article/view/214>
- [3] BSKAP, *Panduan Pembelajaran dan Asesmen Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah Edisi Revisi Tahun 2025*. Jakarta: Badan Standar, Kurikulum, dan Asesmen Pendidikan (BSKAP) Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2025.
- [4] N. Afni, "Penerapan Model Problem Based Learning (PBL) Di Sekolah Dasar," *SHEs Conf. Ser.*, vol. 3, no. 4, pp. 1000–1004, 2020, [Online]. Available: <https://doi.org/10.20961/shes.v3i4.55667>
- [5] E. A. Aprina, E. Fatmawati, and A. Suhardi, "Penerapan Model Problem Based Learning Untuk Mengembangkan Keterampilan Berpikir Kritis Pada Muatan IPA Sekolah Dasar," *Didakt. J. Kependidikan*, vol. 13, no. 1, pp. 981–990, 2024, [Online]. Available: <https://doi.org/10.58230/27454312.496>
- [6] S. R. 'Aisy and I. A. Ardhana, "Analisis Tingkat Keterampilan Berpikir Kritis Siswa Kelas XI IPA SMA PGRI 1 Jombang pada Materi Asam Basa Ditinjau dari Perbedaan Gender," *J. Pendidik. Kim. Undiksha*, vol. 7, no. 2, pp. 17–26, 2023, [Online]. Available: <https://doi.org/10.23887/jjpk.v7i2.67356>
- [7] Muslimin, N. Mukhlisa, and M. Jannah, "hubungan antara motivasi belajar dengan hasil belajar muatan pembelajaran ipa siswa kelas tinggi di sekolah dasar kabupaten pangkep," *Pendas J. Ilm. Pendidik. Dasar*, vol. 09, no. 04, pp. 556–567, 2024.
- [8] M. Carmelita *et al.*, "Pendampingan Pengembangan Lembar Kerja Peserta Didik (LKPD) Matematika Berbasis Model Kolaboratif dengan Pendekatan PMR," *Abdimas Indones. J.*, vol. 5, no. 2, pp. 319–324, 2025, doi: 10.59525/aij.v5i2.1113.
- [9] Zhafira and M. Fadilah, "Analisis Komponen Lembar Kerja Peserta Didik (LKPD) Biologi Fase E Pada Materi Ekosistem yang digunakan di SMAN 10 Padang," *J. Pengabd. Masy. dan Ris. Pendidik.*, vol. 4, no. 2, pp. 8311–8316, 2025, [Online]. Available: <https://doi.org/10.31004/jerkin.v4i2.3197>
- [10] N. P. I. Pebriani, I. B. Putrayasa, and I. G. Margunayasa, "pengembangan e-lkpd berbasis hots (higher order thinking skill) dengan pendekatan saintifik pada pembelajaran IPA tema 8 kelas V SD," vol. 12, no. 1, pp. 76–89, 2022.
- [11] D. T. Novitaningrum, A. Mala, and F. E. Sasmita, "Efektivitas LKPD Berbasis Problem-Based Learning dalam Meningkatkan Literasi Matematis Peserta Didik Madrasah Ibtidaiyah," *J. LENTERA Kaji. Keagamaan, Keilmuan dan Teknol.*, vol. 24, no. 3, pp. 798–809, 2025, [Online]. Available: <https://ejournal.staimnglawak.ac.id/index.php/lentera>
- [12] D. P. Hariyati and P. Rachmadyanti, "pengembangan bahan ajar berbasis liveworksheet untuk siswa sekolah dasar kelas V," *J. Penelit. Pendidik. Guru Sekol. Dasar*, vol. 10, no. 7, pp. 1473–1483, 2022, [Online]. Available: <https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/47566>
- [13] N. B. Sumanik, L. F. Siregar, Y. P. Pasaribu, and Y. Buyang, "Literature Study: Liveworksheet as a Science Learning Media Electronic Student Worksheet in The Merdeka Curriculum," *Tech. Soc. Sci. J.*, vol. 49, no. 1, pp. 374–382, 2023, [Online]. Available: <https://doi.org/10.47577/tssj.v49i1.9828>
- [14] P. Nurgandari, "Pengembangan LKPD Berbasis PBL Integrasi Argumentasi pada Materi Ekosistem dan Perubahan Lingkungan," UIN Syarif Hidayatullah Jakarta, 2022.
- [15] D. Novelni and E. Sukma, "Analisis Langkah-Langkah model Problem Based Learning dalam Analisis Langkah-Langkah Model Problem Based Learning Dalam Pembelajaran Tematik Terpadu Di Sekolah Dasar Menurut Pandangan Para Ahli," *J. Basic Educ. Stud.*, vol. 4, no. 1, pp. 3869–3888, 2021.
- [16] T. U. Widayati, Destrinelli, and M. Sofwan, "The Influence of the Implementation of the Integrated PBL (Problem Based Learning) Model with Differentiated Learning on Students ' Critical Thinking Skills in Science Subjects," *J. Penelit. Pendidik. IPA*, vol. 11, no. 4, pp. 364–371, 2025, doi: 10.29303/jppipa.v11i4.10669.
- [17] R. Rizky, M. Zainuddin, and S. Murdiyah, "Pengembangan LKPD Melalui Video Interaktif Materi Peristiwa Sekitar Proklamasi dengan Penguatan Karakter Semangat Kebangsaan Kelas V SDN," *J. Pembelajaran, Bimbingan, dan Pengelolaan Pendidik.*, vol. 2, no. 10, pp. 933–943,

- 2022, doi: 10.17977/um065v2i102022p933-943.
- [18] L. Pitrianis, D. Padmo, and R. F. Yanti, "pengaruh model pembelajaran problem based learning (pbl) berbantuan lkpD terhadap kemampuan berpikir kritis ditinjau dari kemampuan awal peserta didik," *urnal Ilm. Pendidik. Dasar*, vol. 10, no. 02, pp. 90–106, 2025, [Online]. Available: <https://doi.org/10.23969/jp.v10i02.28349>
- [19] E. S. Felianti and H. Sanoto, "Penerapan Model Problem Based Learning dalam Meningkatkan Keaktifan dan Hasil Belajar Siswa pada Mata Pelajaran IPA SD," *JIIP (Jurnal Ilm. Ilmu Pendidikan)*, vol. 6, no. 9, pp. 7404–7413, 2023, doi: <https://doi.org/10.54371/jiip.v6i9.2959>.
- [20] S. Istiningih and I. Handika, "Analisis Kesulitan Siswa Dalam Menyelesaikan Soal Higher Order Thinking Skills (HOTS) Pada Muatan IPAS Kelas V SDN 40 Cakranegara," *Edukasiana J. Inov. Pendidik.*, vol. 4, no. 4, pp. 1946–1956, 2025, [Online]. Available: <https://doi.org/10.56916/ejip.v4i4.2053>
- [21] R. Rahmaniati, Erlina, and N. Rahmadini, "systematic literature review: application of the problem model learning based on science learning in primary schools," *Bitnet J. Pendidik. Teknol. Inf.*, vol. 10, no. 1, pp. 75–82, 2025, [Online]. Available: <https://doi.org/10.33084/bitnet.v9i2.7582>
- [22] I. U. Masruroh, "pengembangan e-lkpD berbasis problem based learning (PBL) untuk meningkatkan keterampilan berpikir kritis peserta didik pada sub materi zat makanan Development of E-LKPD based on Problem Based Learning (PBL) to Improve Critical Thinking Skills of Stud," vol. 13, no. 2, pp. 370–382, 2024, [Online]. Available: <https://doi.org/10.26740/bioedu.v13n2.p370-382>
- [23] Sugiyono, *Metode Penelitian Pendidikan (Kuantitatif, Kualitatif, Kombinasi, R&D, dan Penelitian Pendidikan)*. Bandung: Alfabeta, 2023.
- [24] A. S. Balqis and A. E. Andriani, "Development of Learning Evaluation Based on Automatic Assessment through Quizizz Paper Mode to Improve Students ' Natural and Social Sciences Learning Outcomes," *J. Penelit. Pendidik. IPA*, vol. 10, no. 6, pp. 3357–3366, 2024, doi: 10.29303/jppipa.v10i6.7251.
- [25] Irmeilyana, Ngudiantoro, S. I. Maiyanti, A. Setiawan, and A. K. Affandi, "Penyuluhan Desain Packing Produk Dan Pemanfaatan Digital Marketing Pada Usaha Kerupuk Di Desa Tanjung Pering Kecamatan Indralaya Utara Kabupaten Ol," *J. Vokasi*, vol. 7, no. 1, pp. 1–10, 2023, doi: <http://dx.doi.org/10.30811/vokasi.v7i1.3308>.
- [26] Y. B. Sembiring, "Pengembangan Lembar Kerja Peserta Didik (LkpD) Berbasis Project Based Learning (Pjbl) Pelajaran Ipa di Kelas Iv SD Negeri 064023 KEMENANGAN TANI T.P 2022/2023," 2023. [Online]. Available: <http://portaluniversitasquality.ac.id:55555/id/eprint/1943>
- [27] S. Fauziah and G. Hamdu, "Implementasi E-LKPD Berbasis ESD pada Kompetensi Berpikir Kritis di SD," *Attadib J. Elem. Educ.*, vol. 6, no. 1, pp. 172–179, 2022, doi: 10.32507/attadib.v6i1.977.
- [28] I. T. Ayuni, E. Bumiarti, and E. Roviati, "Persepsi Guru dan Siswa Tentang Penggunaan E-LKPD dalam Penerapan Model Project Based Learning," *J. Biol. Sci. Educ.* 2025, vol. 14, no. 2, pp. 122–133, 2025, [Online]. Available: <https://doi.org/10.33477/bs.v14i2.8764>
- [29] L. N. Ni'mah and R. Rusnilawati, "STEAM-Inquiry Learning Module Assisted by Liveworksheet for Multiplication Material in Elementary School," *Profesi Pendidik. Dasar*, vol. 10, no. 3, pp. 32–46, 2023, doi: 10.23917/ppd.v10i3.5478.
- [30] Isabela, M. Surur, and Y. Puspitasari, "Penerapan Model PBL (Problem Based Learning) untuk Meningkatkan Kemampuan Percaya Diri Siswa," *J. Pendidik. Tambusai*, vol. 5, no. 2, pp. 2729–2739, 2021.
- [31] I. A. Hapsari and F. D. Prasetyaningtyas, "E-LKPD Berbasis Problem Based Learning pada Hasil Belajar IPS," *J. Ilm. Pendidik. PROFESI GURU*, vol. 6, no. 3, pp. 481–493, 2023, doi: <https://doi.org/10.23887/jippg.v6i3.66104>.
- [32] S. N. Ariadila, Y. F. N. Silalahi, F. H. Fadiyah, U. Jamaludin, and S. Setiawan, "Analisis Pentingnya Keterampilan Berpikir Kritis Terhadap Pembelajaran Bagi Siswa," *J. Ilm. Wahana Pendidik.*, vol. 9, no. 20, pp. 664–669, 2023, [Online]. Available: <https://doi.org/10.5281/zenodo.8436970>
- [33] A. Amalia, C. P. Rini, and A. Amaliyah, "Analisis Kemampuan Berpikir Kritis Siswa Kelas V Dalam Pembelajaran IPA di SDN Karang Tengah 11 Kota Tangerang," *SIBATIK J. J. Ilm. Bid. Sos. Ekon. Budaya, Teknol. Dan Pendidik.*, vol. 1, no. 1, pp. 33–44, 2021, [Online]. Available: <https://doi.org/10.54443/sibatik.v1i1.4>
- [34] R. C. Chairani, "penerapan model pembelajaran project based learning (pjbl) untuk meningkatkan hasil belajar kimia peserta didik pada sub materi struktur atom," 2024. [Online]. Available: <https://rama.unimal.ac.id/id/eprint/9639>
- [35] N. Hamidah, A. Rusilowati, Ellianawati, B. Subali, and W. Lestari, "Analisis kebutuhan e-lkpD berbantuan liveworksheet pada pembelajaran IPA untuk meningkatkan kemampuan berpikir kritis peserta didik sekolah dasar," *Didakt. J. Ilm. PGSD FKIP Univ. Mandiri*, vol. 10, no. 02, pp. 255–265, 2024, doi: <https://doi.org/10.36989/didaktik.v10i2.2965>.
- [36] A. F. Ghaniem, A. A. Rasa, A. H. Oktora, and M. Yasella, *Buku Panduan Siswa Ilmu Pengetahuan Alam dan Sosial untuk SD kelas V*. Jakarta Selatan: Pusat Perbukuan Badan Standar, Kurikulum dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2021. [Online]. Available: <https://buku.kemdikbud.go.id>
- [37] I. Magdalena, Roshita, S. Pratiwi, A. Pertiwi, and A. P. Damayanti, "penggunaan media gambar dalam meningkatkan minat belajar siswa kelas iv di sd negeri 09 kamal pagi," *PENSA J. Pendidik. dan Ilmu Sos.*, vol. 3, no. 2, pp. 334–346, 2021, doi: <https://doi.org/10.36088/pensa.v3i2.1374>.
- [38] M. Albina and K. B. Pratama, "Peran Tujuan Pembelajaran dalam Perencanaan Pembelajaran : Dasar untuk Pembelajaran yang Efektif," *Harmon*.

- Pendidik. J. Ilmu Pendidik.*, vol. 2, no. 2, pp. 55–61, 2025, doi: <https://doi.org/10.62383/hardik.v2i2.1233>.
- [39] A. Anggi, K. Karimah, and W. K. Wardani, “Penerapan Media Video Edukasi Terhadap Motivasi Belajar Siswa Pada Mata Pelajaran Sirah Kelas 5c Salafiyah Ula Icbb Yogyakarta,” *J. Kepemimp. Pengur. Sekol.*, vol. 10, no. 4, pp. 2015–2024, 2025, doi: <https://doi.org/10.34125/jkps.v10i4.1093>.
- [40] P. R. Gultom and D. Wan Syafi’i, “pengembangan e-lkpd berbasis problem based learning (pbl) terintegrasi berpikir kritis pada materi sistem ekskresi manusia kelas XI SMA,” *NUSRA J. Penelit. Dan Ilmu Pendidik.*, vol. 6, no. 4, pp. 843–851, 2025, doi: <https://doi.org/10.55681/nusra.v6i4.3997>.
- [41] A. Mahmudi, W. Kusumaningsih, and Qoriati Mushafanah, “analisis penggunaan media konkret dalam pembelajaran matematika kelas 2 Materi Pengukuran di SD Supriyadi 02 Kota Semarang,” *Didakt. J. Ilm. PGSD FKIP Univ. Mandiri*, vol. 09, no. 02, pp. 4140–4150, 2023, doi: <https://doi.org/10.36989/didaktik.v9i2.1086>.
- [42] K. R. Triani, “pengembangan e-lkpd berbasis problem based learning untuk meningkatkan keterampilan berpikir kritis siswa kelas v pada materi ekosistem,” universitas islam negeri Maulana Malik Ibrahim Malang, 2025. [Online]. Available: <http://etheses.uin-malang.ac.id/id/eprint/77885>
- [43] D. P. Rangkuti and M. Jalal, “Analisis Kelayakan Lembar Kerja Peserta Didik Elektronik Berbasis Liveworksheets pada Materi Sistem Pencernaan Kelas V Sekolah Dasar,” *Sos. J. Ilm. Pendidik. IPS*, vol. 3, no. 3, pp. 351–363, 2025, doi: <https://doi.org/10.62383/sosial.v3i3.1084>.
- [44] C. S. Utami, W. Syahri, and Yusnidar, “Pengembangan e-LKPD Berbasis Problem Based Learning (PBL) Dilengkapi Dengan Augmented Reality (AR) Sebagai Inovasi Pembelajaran Pada Materi Ikatan Kimia Fase F,” *J. Pengabd. Masy. dan Ris. Pendidik.*, vol. 4, no. 1, pp. 1173–1179, 2025, doi: <https://doi.org/10.31004/jerkin.v4i1.1718>.
- [45] I. L. Dewi, “pengembangan website peta digital guna meningkatkan layanan pengguna jasa di bandar udara jenderal ahmad yani semarang,” Politeknik Penerbangan Palembang, 2025. [Online]. Available: <http://repository.poltekbangplg.ac.id/id/eprint/575>
- [46] A. Febriyanti, “pengembangan media pembelajaran flashcard pada materi perubahan wujud benda kelas III SD/MI,” IAIN Metro, 2023. [Online]. Available: <https://repository.metrouniv.ac.id/id/eprint/8642>
- [47] Y. Eka, S. Putra, P. Mahanani, and K. Khotimah, “Pengembangan Soal Evaluasi Berbantuan Website Wordwall pada Mata Pelajaran PPKn Materi Nilai-Nilai Pancasila Kelas,” *Ilmu Pendidik. J. Kaji. Teor. dan Prakt. Kependidikan*, vol. 7, no. 2, pp. 74–84, 2022, doi: [10.17977/um027v7i22022p74-84](https://doi.org/10.17977/um027v7i22022p74-84).
- [48] K. Kurniawati, T. Tukiyo, and B. P. Sakti, “Pengembangan Media Pembelajaran Berbasis Cerita Bergambar Untuk Meningkatkan Hasil Belajar Siswa Kelas V SDIT Persada Bayat Universitas Widya Dharma Klaten , Indonesia Media Pembelajaran Berbasis Cerita Bergambar untuk Meningkatkan Hasil Belajar Siswa,” *DHARMA ACARIYA Nusant. J. Pendidikan, Bhs. dan Budaya*, vol. 2, no. 2, pp. 187–197, 2024, doi: <https://doi.org/10.47861/jdan.v2i2.1237>.
- [49] D. B. Maha and K. Manalu, “Pengembangan E-LKPD Berbasis Problem Based Learning (PBL) dalam Meningkatkan Keterampilan Berpikir Kritis Pada Materi Sistem Peredaran Darah Kelas XI IPA di SMA Negeri 1 Lau Baleng,” *Biosci. J. Ilm. Biol.*, vol. 13, no. 3, pp. 2111–2123, 2025, doi: <https://doi.org/10.33394/bioscientist.v13i3.17575>.
- [50] R. Z. R. Amelia and G. Trimulyono, “pengembangan e-lkpd liveworksheet berbasis inkuiri terbimbing pada materi virus untuk melatih keterampilan berpikir kritis peserta didik kelas X SMA,” *Bioedu Berk. Ilm. Pendidik. Biol.*, vol. 13, no. 3, pp. 562–572, 2024, doi: <https://doi.org/10.26740/bioedu.v13n3.p562-572>.
- [51] H. Firtsanianta and I. Khofifah, “efektivitas e-lkpd berbantuan liveworksheet untuk meningkatkan hasil belajar peserta didik,” *Proc. Conf. Elem. Stud.*, vol. 1, no. 1, pp. 140–149, 2022.
- [52] Solehatunisa, H. Purwanto, and N. Sholihat, “Pengembangan E-LKPD Berbasis PBL dengan TTS Interaktif untuk Meningkatkan Kecerdasan Naturalis pada Materi Keanekaragaman Hayati,” *JPIM J. Penelit. Ilm. Multidisipliner*, vol. 02, no. 02, pp. 425–436, 2025, [Online]. Available: <https://ojs.ruangpublikasi.com/index.php/jpim/article/view/742>
- [53] S. R. P. Rahayu, “Peserta Didik Aktif dengan Model Pembelajaran Problem Based Learning,” *SHEs Conf. Ser.*, vol. 4, no. 5, pp. 2024–2029, 2024, [Online]. Available: <https://doi.org/10.20961/shes.v4i5.66361>
- [54] R. P. Sonjaya, F. R. Aliyya, S. Naufal, and M. Nursalman, “Pengujian Prasyarat Analisis Data Nilai Kelas : Uji Normalitas dan Uji Homogenitas,” *J. Pendidik. Tambusai*, vol. 9, no. 1, pp. 1627–1639, 2025.
- [55] M. Ayu, A. Putra, and M. F. Rafli, “Pengaruh Metode Learning Start With A Question (LSQ) Terhadap Hasil Belajar Pada Pembelajaran IPAS Siswa Kelas V Sd Negeri 2 Seulalah,” *J. Basic Educ. Stud.*, vol. 9, no. 1, pp. 17–25, 2026.
- [56] A. Novitasari, R. Wulandari, and R. Oktafiani, “Pengaruh Model RADEC Berbantuan Liveworksheets Terhadap Kreativitas Peserta Didik,” *J. Jeumpa J. Pendidik. Sains Biol.*, vol. 12, no. 1, pp. 36–44, 2025, doi: [10.33059/jj.v12i1.11480](https://doi.org/10.33059/jj.v12i1.11480).
- [57] B. R. Fauzi and Winarto, “survei kemampuan berpikir kritis ditinjau dari motivasi belajar siswa SD / MI DI DESA SURUSUNDA,” *Univ. Perad.*, no. 1, pp. 75–85, 2023, [Online]. Available: <http://repository.peradaban.ac.id/id/eprint/1538>
- [58] R. M. Ayirahma and Muchlis, “pengembangan e-lkpd berorientasi model pbl untuk meningkatkan keterampilan berpikir kritis pada materi asam basa,” *J. Pendidik. Indones.*, vol. 04, no. 06, pp. 675–683, 2023, [Online]. Available: <https://doi.org/10.59141/japendi.v4i6.1961>

- [59] P. D. Sundari and D. Sarkity, "Keterampilan Berpikir Kritis Siswa SMA pada Materi Suhu dan Kalor dalam Pembelajaran Fisika," *J. Nat. Sci. Integr.*, vol. 4, no. 2, pp. 149–161, 2021, doi: <http://dx.doi.org/10.24014/jnsi.v4i2.11445>.
- [60] E. M. L. Karim and A. S. Perdamean, "Analisis soal HOTS pada Buku Studio Express A1," *VISA J. Visions Ideas*, vol. 4, no. 3, pp. 2448–2453, 2024, doi: <https://journal-laaroiba.com/ojs/index.php/visa/4280>.
- [61] Nurdiyati, M. Novita, and S. Patonah, "Analisis Keterampilan Berpikir Kritis Siswa dalam Pengembangan Modul Ajar Berdiferensiasi Berorientasi Education for Sustainable Development pada Materi Green Chemistry," *Didakt. J. Kependidikan*, vol. 14, no. 1, pp. 167–178, 2025, doi: <https://doi.org/10.58230/27454312.1665>.
- [62] A. F. Rusdiyana, D. Widyartono, and F. Taufiqurrahman, "Kesulitan Guru dalam Mengembangkan Kemampuan Berpikir Kritis Siswa Kelas XI SMA melalui Penulisan Karya Ilmiah," *GHANCARAN J. Pendidik. Bhs. Dan Sastra Indones.*, vol. 7, no. 1, pp. 159–173, 2025, doi: [10.19105/ghancaran.v7i1.15909](https://doi.org/10.19105/ghancaran.v7i1.15909).
- [63] Sarina, "pengembangan lembar kerja peserta didik (lkipd) berbasis model pembelajaran search, solve, create, and share (sscs) untuk mendukung kemampuan berpikir kritis matematis siswa SMK KELAS X," 2023.
- [64] J. Y. Zebua, Y. Zega, and Y. N. Telaumbanua, "Analisis Kemampuan Berpikir Menyelesaikan Soal Matematika Kritis Siswa dalam," *Didakt. J. Kependidikan*, vol. 13, no. 001, pp. 587–594, 2024, doi: <https://doi.org/10.58230/27454312.1212>.
- [65] F. R. Izharifa, F. Fakhriyah, and S. Masfuah, "Efektivitas Model Problem Based Learning Berbantuan Media KIT IPA terhadap Kemampuan Berpikir Kritis Siswa," *WASIS J. Ilm. Pendidik.*, vol. 5, no. 2, pp. 101–108, 2024, doi: <https://doi.org/10.24176/wasis.v5i2.12162>.