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Developing Problem-Based Learning Student Worksheets to Enhance Higher-Order Thinking Skills in Elementary Science Education

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Abstract: The need to strengthen students' analytical, evaluative, and creative thinking in Science Education has prompted the development of instructional tools that go beyond rote memorization. This research aims to develop Student Worksheets using a Problem-Based Learning approach to improve Higher-Order Thinking Skills among fifth-grade elementary students. The study employed a research and development method adapted from the Plomp model, consisting of preliminary research, prototyping, and assessment phases. Data were collected through expert validation, teacher and student response questionnaires, and learning outcome tests involving 30 students in one elementary school. The developed worksheet demonstrated very high validity in content, design, and language. Practicality scores from individual, small group, and classroom trials showed consistent results in the "very practical" category. Effectiveness was confirmed through a notable increase in student scores from pre-test to post-test, reaching a class mastery level of 80 percent. The findings suggest that the worksheet successfully fosters student engagement in scientific inquiry while enhancing cognitive skills. This product offers a practical and pedagogically sound tool to support active learning in elementary Science Education and contributes to the broader development of inquiry-based learning strategies in the classroom.

Keywords: Elementary Education; Higher-Order Thinking; Problem-Based Learning; Science Learning; Student Worksheet

Introduction

In the twenty-fiirst century, the demand for quality education has shifted its focus not only to transferring knowledge but to developing the capacity for advanced reasoning, resolution of problems, and independent learning. The very aim of modern education is to cultivate Higher-Order Thinking Skills to analyze, evaluate, and create. Such skills would allow students to transfer knowledge to unfamiliar contexts, provide approaches to deal with real-life situations, and take part in vibrant social and scientific dialogues.

Higher-Order Thinking Skills take an even greater significance in Science Education. Science is much more than a mere collection of facts; it consists of an active inquiry that requires interpretation, experimentation, and logical argumentation. Hence, instruction at the elementary level must go beyond rote memorization and facilitate students' engagement in authentic scientific endeavors including observation, hypothesis testing, data collection, and reasoning. Precisely fostering such scientific practices equips the learners with basic training that acts as a scaffold for obtaining lifelong scientific literacy.

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However, much of the instruction in elementary science classrooms continues with traditional pedagogy that emphasizes factual recall and mechanical exercises. This confines students' opportunities to explore ideas, ask questions, and find answers to problems based on real-life contexts. An increasing volume of literature suggests that the traditional practices in most classrooms alone will not adequately ensure training in Higher-Order Thinking Skills (Pitriyana & Karnita Arafatun, 2022). This type of limitation on pedagogy is said to have been linked to poor academic performance, especially in the context of Science Education.

As an obvious case of this condition, at SDN 14 Pincuran VII, data from the Final Semester Assessment in the first semester of the 2024/2025 academic year showed that 55% of the students failed to achieve the minimum required score to pass the Science Education course. This alarming data points to a major deficiency in students' scientific knowledge and cognitive development. It therefore underscores the urgent need for educational innovations that are able to support effectively the younger learners' development of advanced thinking skills.

One of the key factors contributing to this condition is the lack of well-designed instructional materials that integrate active learning strategies. Student Worksheets among those materials are the most-used ones in guiding learning activities in elementary classrooms. However, most current Student Worksheets are highly procedural, focusing on drill exercises to the exclusion of analyzing situations or engaging in inquiry (Khovivah et al., 2022). In that context, the design of Student Worksheets should be rethought as tools for deeper learning and knowledge engagement.

Problem-Based Learning is a prominent teaching strategy closely aligned with the objectives of Higher-Order Thinking Skills. It requires students to investigate a complicated and ill-structured real-world problem, creating the potential for self-directed learning, collaboration, and solution generation through inquiry (Hamdani et al., 2022). In Science Education, Problem-Based Learning provides a context for the development of Higher-Order Thinking Skills because it mirrors scientific inquiry and enables students to learn from experiences.

This means that when Problem-Based Learning is applied in Student Worksheets, these materials are converted into instruments for active thinking and experiential learning. The Student Worksheets encourage students to identify problems, gather information, hypothesize, deliberate and experiment, and reflect. These arrangements promote effective comprehension of content and metacognitive awareness, as well as collaborative intellectual independence (Khovivah et al., 2022). The student worksheets therefore support both types of learning concerning cognitive processes.

However, there exists strong empirical evidence to support the role of Problem-Based Learning Student Worksheet in Elementary School. Kesumawati et al. (2022) developed the V grade PBL Mathematics worksheets and validated that it contains high validity level, practicality, and effectiveness. Mulbasari et al. (2021) similarly published a study revealing that well-structured Problem-Based Learning worksheets had significant effect on students' conceptual understanding, input, and output of learning.

To this, Arianty et al. (2021) added that the effective worksheet design would be undergirded by cultural and environmental contexts from which students emerge. Such content will motivate and make understanding of otherwise difficult scientific concepts easier as meanings draw close from the context of the life of students. This view is confirmed by Mailani et al. (2022) who argue that real-life contextualization similar to that exerted in Realistic Mathematics Education is philosophical to Problem-Based Learning and central to the construction of Higher Order Thinking Skills.

At SDN 14 Pincuran VII, there, the development of Problem-Based Learning Student Worksheets is pertinent and currently pressing since students have difficulty mastering Science Education. Such worksheets can build a bridge between the desired aspirations of the curriculum and the realities of what goes on within the classroom, helping teachers move from teacher-centered instruction to student-centered exploration. They are facilitated pathways for students to construct scientific knowledge as well as refine analytical and evaluative competencies in space but structured.

In addition, Problem-Based Learning Student Worksheets also seem to encourage collaborative learning and arguing their reasoning while owning their learning experiences and, therefore, nurture academic self-efficacy and resilience. This is essential in describing 21 st-century qualities of education feature growth-mindset. According to Halimah et al. (2023), Problem-Based Learning is highly applicable in Science Education as a power booster to detect critical thinking in students, even up to interlinking scientific content with real-life phenomena.

The objective of this research, hence, is the development of Problem-Based Learning Student Worksheets to enhance Higher-Order Thinking Skills in elementary Science Education. Thus, it meets the twin objectives of developing cognitive competencies in students while also providing teachers with sound instructional materials consistent with 21st-century learning principles.

The development, validation and application of Problem-Based Learning Student Worksheets has theoretical and practical implications regarding science pedagogy. In theoretical terms, it expands the debate on designing educational materials within the spheres of constructivist and inquiry-based learning. Practically, it avails teachers of handy resources to make Science Education an interesting, reflective and intelligent stimulating experience for elementary students.

Method

This study is Research and Development for Student Worksheet in the Science Education subject based on Problem Based Learning for fifth graders in elementary schools. The development model is adapted from the Plomp framework which consists of three main phases: preliminary research, prototyping phase, and assessment phase (Plomp,2013). This approach has been selected to ensure that the resulting product is valid, practical, and effective through a sustainable development cycle.

The preliminary research phase included a number of activities conducted by the researcher to identify actual learning problems and needs, analyze the characteristics of the Student Worksheet, do a curriculum review, analyze learning outcomes, perform content analysis, and identify conditions of students or teachers through needs assessment questionnaires and literature studies. The findings in this phase served as the basis for designing the initial draft of the contextual-engaging Student Worksheet that supports students' active learning in the classroom.

The design, development, and refinement of the Student Worksheet through the formative evaluation were accomplished in the prototyping phase. The self-evaluation of the first prototype was in conjunction with the expert judgments provided by validators from the subject matter, media, and language fields. Subsequently, one-on-one trials with students were conducted, followed by small group evaluations. This phase ensured that the feedback gathered before full implementation was on content clarity, language readability, and visual attractiveness. Instruments used in this phase were validation questionnaires and observation sheets. Validation results were analyzed using Aiken's V formula (Azwar, 1997).

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Information:
V : Validity Score
S : $\sum s$ $(s = r - lo)$
lo : The lowest validity rating score
r : The number given by an appraiser
c : The highest validity rating score
n: Number of items

The value of V obtained is then interpreted into a validity classification as shown in Table 1.

Table 1. *Validation Criteria*

Achievement Level	Category
≥ 0,6	Valid
< 0.6	Invalid

Meanwhile, the initial feasibility aspect was analyzed using the percentage of practicality on a limited scale (Riduwan, 2019).

$$P = \frac{f}{N} \times 100\% \quad (2)$$

The practicality criteria can be seen in Table 2.

Table 2. Practicality Criteria

Score Range	Criteria
80% < x ≤ 100%	Highly Practical
60% < x ≤ 80%	Practical
40% < x ≤ 60%	Fairly Practical
20% < x ≤ 40%	Less Practical
0% < x ≤ 20%	Not Practical

The assessment phase focuses on the final evaluation of the practicality and effectiveness of the Student Worksheet in real classroom implementation. Practicality is evaluated through a field test involving teachers and students, using a practicality questionnaire. The effectiveness of the Student Worksheet based on Problem Based Learning is measured by comparing students' learning outcomes before and after using the product (pre-test and post-test). The data are analyzed using the N-Gain formula.

$$(g) = \frac{Posttest\ score - Pretest\ score}{Maximum\ possible\ score - Pretest\ score} \quad (3)$$

The calculation results are interpreted using the gain index (g), following the classification by Hake (1998) as presented in Table 3.

Table 3. Categories of Normalized Gain Index Values

Gain Index (g)	Category
(g) ≥ 0.70	High
0.30 ≤ (g) ≥ 0.70	Medium
(g) < 0.30	Low

Students' knowledge competence is considered mastered if it reaches the minimum required score to pass the Science Education course; conversely, students are considered not yet mastered if their score is below the predetermined standard. The minimum required score to pass the Science Education course is set at 70. To analyze students' knowledge competence data, both at the individual and class levels, Equation (4) can be applied.

$$KK = \frac{JT}{JS} \times 100\% \quad (4)$$

Based on Equation (4), KK refers to the classical mastery level, JT is the number of students who achieve mastery, and JS is the total number of students. At the class level, if at least 75% of students reach the mastery threshold, the product used is considered effective (Rohmawati, 2015).

Result and Discussion

The development of Student Worksheets based on Problem Based Learning for the water cycle topic in Grade V Elementary School follows a systematic procedure using the Plomp model, which includes preliminary research, prototyping, and assessment phases tailored to the research needs. This development aims to produce worksheets that strengthen students' higher-order thinking skills in Science Education. Based on the established objectives and procedures, the following research data were obtained.

Preliminary Research Findings
Needs Analysis

The observation results indicate that Science Education learning in the classroom is still predominantly conducted through the lecture method, resulting in students' low literacy skills and limited interest in solving problems that require higher-order thinking skills. Many students prefer to ask the teacher directly rather than read and analyze the given problems independently, and while high-achieving students tend to complete tasks on their own, those with moderate and lower abilities often wait for answers from their peers. In addition, Student Worksheets that could support active and independent learning are not optimally used. Interviews with teachers confirmed that students struggle with tasks demanding higher-order thinking skills and that teachers still rely heavily on lectures for practical reasons, especially when teaching complex material. Although some have tried using Problem Based Learning, its implementation often does not align with lesson plans, causing teachers to revert to conventional methods. Teachers also rarely design Student Worksheets containing non-routine problems due to limited ideas and time constraints. These findings clearly indicate the need for relevant and systematic development of Student Worksheets based on Problem Based Learning to strengthen students' higher-order thinking skills in Science Education.

Learner Analysis

Based on Piaget's developmental theory, upper elementary school students are at the final stage of concrete operational development and entering the early formal operational stage, which enables them to think abstractly and logically, enjoy group discussions, express opinions, and solve problems through simple research and experimentation. This indicates that the appropriate learning method for students at this stage should not be one-way instruction, but rather approaches that foster the development of abstract thinking skills. Questionnaire results show that students still face difficulties in solving problems, particularly those related to real-life situations, and prefer Student Worksheets that are colorful, visually appealing, and include illustrations. These findings serve as important considerations for the researcher in developing learning products that are aligned with students' characteristics.

Curriculum Analysis

The researcher conducted a curriculum analysis to determine the relevant learning outcomes as the basis for developing the Student Worksheets, since not all outcomes can be addressed with the same materials. The selected topic is the water cycle, aligned with the Learning Objectives Pathway in the Decree of the Head of the Education Standards, Curriculum, and Assessment Agency Number 032/H/KR/2024 under the Merdeka Curriculum. The targeted objectives include students analyzing the benefits of water, identifying components of the water cycle, distinguishing surface water and groundwater, and examining human impacts, factors affecting clean water availability, and efforts to maintain clean water sustainability.

Concept Analysis

The concept analysis was conducted to determine the scope of the material to be included in the Student Worksheets so that the content is structured and shows clear connections between concepts. This analysis refers to the relevant material and the Learning Objectives Pathway applied in Grade V of Sekolah Dasar Negeri 14 Pincuran VII. Based on the results, the material covered in the Student Worksheets is the water cycle. The development of these Student Worksheets is driven by the initial analysis findings, which revealed the absence of practical and interactive teaching materials to support

students in understanding the water cycle concept and enhancing their higher-order thinking skills. With these Student Worksheets, it is expected that students will more easily understand the material and achieve the learning objectives set out in the curriculum.

Results of the Prototyping Phase

At this stage, the design and development of the Student Worksheet were carried out based on the findings obtained during the preliminary research phase. The Student Worksheet based on Problem Based Learning was systematically developed and refined to align with the applicable curriculum and the specific characteristics of the students. The design process emphasized contextual relevance, interactive learning experiences, and ease of access, ensuring that the content supports students' conceptual understanding and encourages active participation throughout the learning process.

Design a Cover Page for the Student Worksheet

An envelope will show the Student Worksheet for Natural Science and its fifth theme, the Water Cycle. It consists of a title, subject, the visual representation of the water cycle, and the name and institution of the author. The layout is designed to be attractive and contextually relevant for fifth-grade elementary school students, featuring natural elements and clear imagery to create an engaging first impression and reflect the environmental theme of the material.

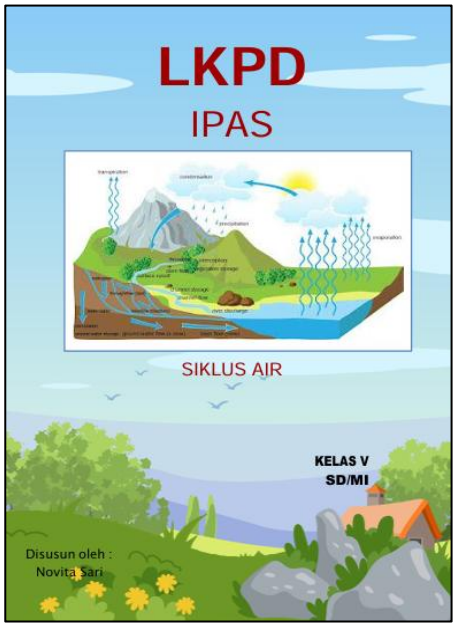


Figure 1. Cover page

Table of Contents

The table of contents presents a clear and systematic structure of the student worksheet, starting from the foreword, learning objectives, and concept maps, to detailed topics such as the water cycle, surface and groundwater, and water conservation. Each section, including the student worksheets, competency test, references, and author information, is listed with corresponding page numbers to help users easily locate and access the material.

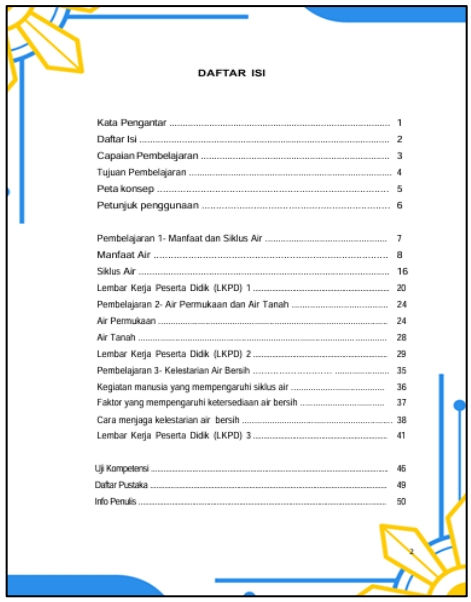
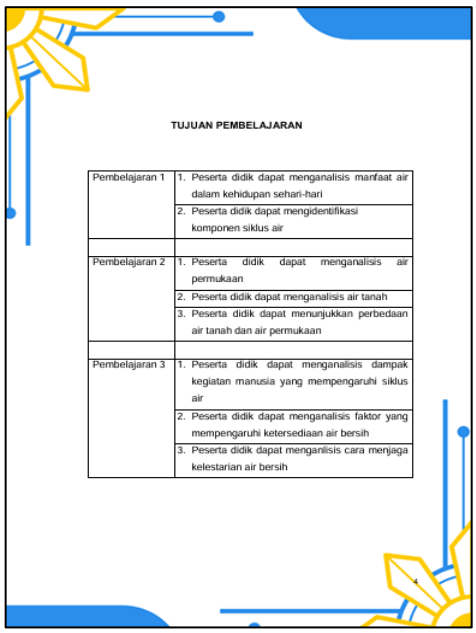

DAFTAR ISI

Figure 2. Table of Contents Display

Learning Outcomes

The learning outcomes define what students should achieve: understanding the water cycle, identifying water sources, analyzing human impacts, and suggesting ways to conserve clean water.


TUJUAN PEMBELAJARAN

Pembelajaran 1	1. Peserta didik dapat menganalisis manfaat air dalam kehidupan sehari-hari
	2. Peserta didik dapat mengidentifikasi komponen siklus air
Pembelajaran 2	1. Peserta didik dapat menganalisis air permukaan
	2. Peserta didik dapat menganalisis air tanah
	3. Peserta didik dapat menunjukkan perbedaan air tanah dan air permukaan
Pembelajaran 3	1. Peserta didik dapat menganalisis dampak kegiatan manusia yang mempengaruhi siklus air
	2. Peserta didik dapat menganalisis faktor yang mempengaruhi ketersediaan air bersih
	3. Peserta didik dapat menganlisis cara menjaga kelestarian air bersih

Figure 3. Display of Learning Achievements

Concept Map

This concept map explains the benefits of water, the water cycle process, types of water cycles, and ways to maintain clean water sustainability.

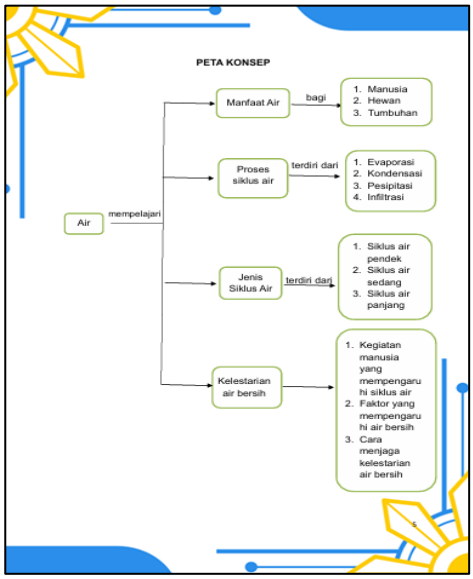


Figure 4. Concept Map Display

Instructions for use

This section provides clear guidance for both teachers and students on how to use the student worksheet effectively. It outlines the roles of teachers in facilitating learning and assisting students, and it reminds students to prepare well, follow the steps carefully, and seek help if they encounter any difficulties.

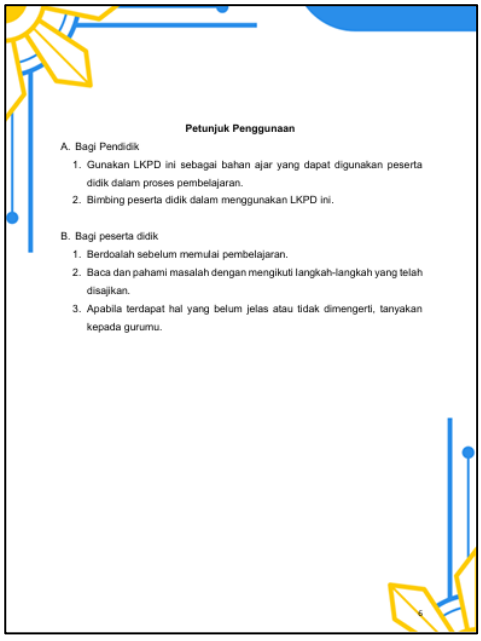


Figure 5. Display of Instructions for Use

Learning Activities in the Learning Process

This student worksheet is designed using a Problem-Based Learning approach. Through this activity, students are encouraged to identify real problems in their surroundings, discuss them in groups, and develop solutions independently and creatively.

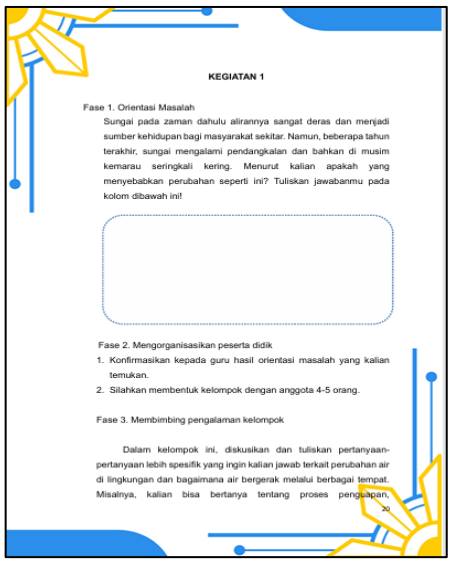


Figure 6. Display of material in learning activities

Competency Test

This competency test focuses on the topic of the water cycle and is presented in multiple-choice format. It aims to assess students' understanding of key stages such as evaporation, condensation, and precipitation. One item includes a visual diagram to enhance scientific visual literacy. This assessment activity reinforces conceptual mastery through real-life contextual applications.

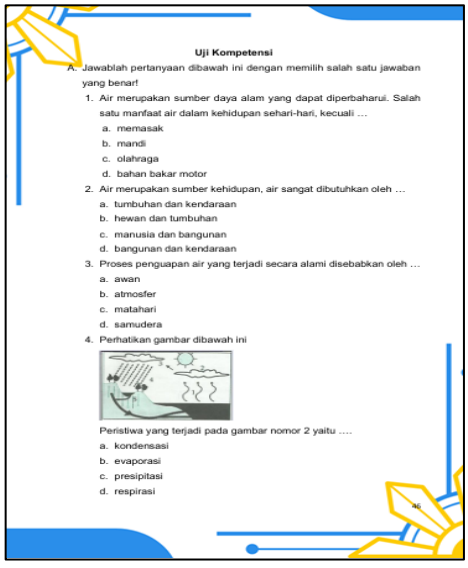


Figure 7. Display of Competency Test

Bibliography

The reference list includes a combination of textbook sources and credible online materials related to the water cycle and water conservation. These sources support the development of content, assessment items, and contextual learning based on environmental issues.

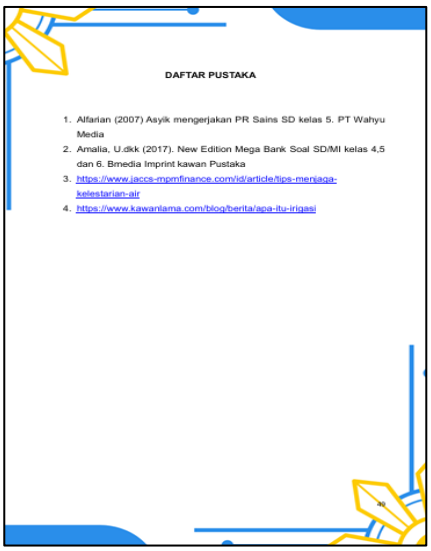


Figure 8. Display of Bibliography

Author Profile Page

The author profile page includes a brief biography of the student worksheet's author, comprising the author's name, student identification number (NIM), current study program, residential address, and contact email.

Figure 9. Author Profile Display

Validity test

1) Media Validity

The media validation phase was carried out by a validator from the Educational Technology department, Mr. Nofri Hendri, M.Pd. The validation process was conducted in two stages due to suggestions, revisions, or comments provided by the validator regarding the Student Worksheet. If the validator identified the lowest scores or provided critical feedback, revisions were made before proceeding to the second validation stage. The results of the media expert's validation of the Student Worksheet based on the Problem-Based Learning approach are presented as follows:

Table 4. Media Validator Assessment Results

Aspect	Validity Score	Category
Completeness of Media Components	1.00	Valid
Cover Design	0.94	Valid
Content	1.00	Valid
Average Validity Score	0.98	Valid

2) Validation of material experts

The content validation was conducted by a subject matter expert through a structured assessment questionnaire. The validator was a lecturer from the Department of Biology at Universitas Negeri Padang, Dr. Muhyiatul Fadilah, M.Pd. The validation process was carried out in two stages due to suggestions, corrections, and comments provided regarding the Student Worksheet. The assessment focused on three main criteria: content feasibility, presentation feasibility, and the alignment between the Student Worksheet and the steps of the Problem-Based Learning model. The results of the content expert's validation are presented in Table 5.

Tabel 5. Material Validator Assessment Results

Aspect	Validity Score	Category
Content Feasibility	1.00	Valid
Presentation Feasibility	1.00	Valid
Alignment Between the Student Worksheet and Problem-Based Learning Steps	0.96	Valid
Average Validity Score	0.98	Valid

3) Language validity

The language validation was conducted by a language expert through the distribution of an assessment questionnaire. The validator was a lecturer from the Department of Language and Literature Education at Universitas Negeri Padang, Dr. Yenni Hayati, M.Hum. The evaluation covered several aspects, including language appropriateness, sentence structure

suitability, and student readability. The results of the language expert's assessment are presented in Table 6.

Table 6. Language validity Result

Aspect	Validity Score	Category
Appropriateness with Language Rules	1.00	Valid
Sentence Structure Suitability	1.00	Valid
Appropriateness for Students	1.00	Valid
Average Validity Score	1.00	Valid

Practicality test

1) Results of the One-to-One Practicality Evaluation

The practicality test of the Student Worksheet was conducted using a response questionnaire completed by four Grade V students from SDN 14 Pincuran VII with varying academic abilities. Students used the Student Worksheet independently, without prior instruction. The evaluation covered readability and clarity of the material (85%), usability and ease of use (85%), attractiveness (89%), and time allocation (70%). The average percentage of all indicators reached 82%, placing the Student Worksheet in the "Very Practical" category and indicating its suitability for independent use in the learning process.

2) Results of the Small Group Practicality Evaluation

Following the individual evaluation, a small group evaluation was conducted with eight Grade V students of low to moderate ability to assess the practicality of the validated Student Worksheet. The findings reveal that readability and clarity got 81%, usability got 75%, attractiveness received 88%, and the assignment of time had 70% with an indicator average achievement of 87% .Here, it can be considered that Student Worksheets fall in the category "Very Practical" and can very well be used for group learning activities.

3) Results of the Practicality Evaluation Based on Educator Responses

With a teacher response questionnaire, the practicality test of the Student Worksheet based on teacher responses was conducted. As per the results, readability and clarity of the material reached 92%, usability and ease of control secured 87%, attractiveness achieved 90%, and 80% were earned for the time allocation aspect. All components were categorized into the "Very Practical" category. The overall average percentage of indicator achievement was 91%, implying that the Student Worksheet is practically very useful for classroom use, and feasible in a teacher's point of view.

4) Results of the Practicality Evaluation Based on Learner Responses in the Large Group

The practicality test of the Student Worksheet in the field trial (large group) was conducted using a student response questionnaire. The evaluation involved students completing the Student Worksheet and providing feedback on key components. The results showed that readability and clarity scored 81%, usability and ease of use 85%, attractiveness 86%, and time allocation 71%. The overall average indicator achievement was 81%, placing the Student Worksheet in the "Very Practical" category and confirming its effectiveness for broader classroom implementation.

Effectiveness test

The use of the Student Worksheet based on the Problem-Based Learning model for the water cycle material in Grade V was effective in improving students' knowledge competence, as indicated by the increase in scores from the pretest to the posttest. The results of the students' knowledge competence assessment are presented in Table 7.

Table 7. N-Gain Score Results for Knowledge Competence

Test	Lowest Score	Highest Score	Average Score	<g>	Criteria
Pretest	25	80	51.67	0.62	Medium
Posttest	65	95	82.33		

Based on Table 7, the improvement in students' knowledge competence after using the Student Worksheet based on the Problem-Based Learning model for the water cycle material in Grade V falls within the medium criteria. Students are considered to have achieved mastery if they obtain a score of 70 or higher; otherwise, they are categorized as not yet mastering the material. In the posttest, 24 students achieved mastery, while 6 students did not. The overall class mastery level reached 80%. According to Rohmawati (2015), if classical mastery exceeds 75%, the learning product is considered effective. Therefore, the Student Worksheet based on the Problem-Based Learning model is effective in improving students' knowledge competence on the water cycle topic in Grade V.

This study developed a Student Worksheet based on the Problem-Based Learning approach in the context of Science instruction for Elementary School students, with the primary aim of enhancing Higher Order Thinking Skills. The resulting product showed a high degree of validity and practicality based on expert evaluation and implementation in actual classrooms. Moreover, the effectiveness of the Student Worksheet in the learning process could be well observed in the improved student skills in analysis, evaluation, and creative problem-solving.

The Students' Worksheet was declared valid after being assessed by the experts for content, language, and design, while its practical aspects were found from the positive responses of students and teachers after its use in the class. Students' Higher Order Thinking Skills were improved as they engaged in contextual problems that involved analysis, making decisions, and logical reasoning.

These research findings concurred with Fahrurrozi et al. (2023), stating that the implementation of the Problem-Based Learning model through a lesson study approach had a significant effect on improving university students' Higher Order Thinking Skills in the history of mathematics course. Students were instructed to perform critical analysis and evaluation of information through collaborative and reflective problem-solving activities.

Similarly, Selirowangi et al. (2024) asserted that the sequence of steps taken in the Problem-Based Learning model, namely problem orientation, student organization, guided investigation, development of student work, and final analysis and evaluation, established a more energetic and beneficial learning atmosphere. This learning model worked well for improving the teaching quality of vocational school settings and could be adjusted to fit within the pedagogical framework of the elementary education level.

Regarding the development of the instructional materials, Rezeki et al. (2023) developed Student Worksheets for thematic learning in grade V of Elementary School based on Problem-Based Learning. They validated the worksheets and categorized them as "very valid," stating an average score of 3.79, while the practicality assessment scored an average of 3.83. Their findings confirmed that Student Worksheets based on Problem-Based Learning are not just content valid but also capable of providing active and meaningful learning experiences.

A corresponding study by Dwi et al. (2024) confirmed that the effectiveness of the Problem-Based Learning approach to the development of Student Worksheets achieved a content validity of 89%, practicality of 90%, and effectiveness given by an average student score of 90. These confirmatory results advocated that problem-based instructional materials have significant potential in enhancing critical thinking skills and learning outcomes of Elementary School students.

Herayani et al. (2024) also developed the Science-based Student Worksheet following the 4-D instructional design model. The study reported an achieved content validity of 94.54% for subject matter experts and 88.23% for media experts, while student trials showed a practicality level of 92.22%. The Worksheet was designed through contextualized content that aligned closely to students' real-life experiences, making the whole process of learning relevant and easier to grasp.

Although the research demonstrated successful development and implementation of the Student Worksheet based on Problem-Based Learning, several challenges emerged during classroom application. Common obstacles included limited teacher understanding of the Problem-Based Learning syntax, lack of professional training in designing innovative instructional materials, as well as time and resource constraints in facilitating active and collaborative learning. Herayani et al. (2024) highlighted that many teachers continue to rely solely on thematic textbooks and are unfamiliar with designing Student Worksheets grounded in the Problem-Based Learning approach.

Variations in research outcomes may be attributed to factors such as the learning environment, students' background, teachers' readiness, and institutional support. Nonetheless, a consistent trend indicates that systematic implementation of the Problem-Based Learning model through structured instructional materials like Student Worksheets has a positive impact on the development of Higher Order Thinking Skills.

Therefore, this study contributes meaningfully both theoretically and practically. From a theoretical standpoint, it broadens the understanding of the effectiveness of the Problem-Based Learning approach in elementary education. From a practical perspective, the development of the Student Worksheet offers a concrete solution for teachers in designing instruction that nurtures reasoning, critical thinking, and intellectual independence. It is recommended that ongoing professional training be provided to teachers in order to enhance their capacity to develop relevant, contextual, and problem-oriented instructional materials.

Conclusion

This study aimed to develop Student Worksheets based on the Problem-Based Learning model to enhance Higher-Order Thinking Skills in Science education at the elementary school level. The objective was addressed through a systematic sequence of steps, including needs analysis, learner characteristics assessment, validation, and product effectiveness testing. Expert validation confirmed that the Student Worksheets achieved a very high level of validity across content, language, and media aspects. The practicality of the product was also rated very high based on positive responses from both students and teachers during individual, small-group,

and field trials. Classroom implementation demonstrated that the use of these Student Worksheets significantly improved students' abilities in analysis, evaluation, and scientific problem-solving.

The successful attainment of the study's primary objective was supported by the effective integration of Problem-Based Learning principles into the design of the Student Worksheets. Students actively participated in learning processes and showed marked improvements in Higher-Order Thinking Skills as reflected in pre-test and post-test results. The product was found to be contextually relevant, aligned with learners' characteristics, and capable of facilitating meaningful and reflective learning. Thus, this research contributes practical value by offering a problem-based learning solution for elementary Science classrooms, while also reinforcing theoretical perspectives on the importance of innovative instructional materials in fostering active and independent learning.

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Author Contributions

The research had a number of key players: Nofri Hendri, M.Pd., was a media validator; Dr. Yenni Hayati, S.S., M.Hum., validated the language aspects; and Dr. Muhyatul Fadilah, S.Si, M.Pd., was the material validator. Prof. Dr. Zelhendri Zen, M.Pd., Ph.D., served as the main supervisor and provided extensive academic support throughout the research process. We would also like to express our heartfelt thanks to our parents, dear friends, and colleagues for their moral support and encouragement during the course of this study.

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Conflicts of Interest

The authors declare no conflict of interest

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