DEVELOPMENT OF PROBLEM BASED LEARNING LKPD TO IMPROVE CRITICAL THINKING AND COLLABORATION SKILLS STUDENTS IN JUNIOR HIGH SCHOOL

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Abstract

Collaboration skills and critical thinking abilities are essential 21st-century skills needed in both education and daily life. This Research and Development study aims to develop a problem-based learning LKPD (Student Worksheet) that is valid, practical, and effective. The LKPD was developed to enhance students' collaboration skills and critical thinking abilities using the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation). The subjects of this study were the eighth-grade students of SMPN 7 Menui Satap. The results showed that the developed LKPD was highly valid, with validity scores of 95% from Validator 1 and 92.14% from Validator 2. It was also very practical, with a practicality score of 95.5%. Furthermore, it was moderately effective in improving collaboration skills, with an average score of ($M= 78.25\%$), and highly effective in enhancing critical thinking abilities from 43 to 81 and Cohen's $d=0.88$, categorized as a huge effect.

Keywords: LKPD, Problem-based learning, ADDIE model, collaboration skills, critical thinking skills

Introduction

In the 21st century, critical and collaborative thinking skills are essential for supporting students' intellectual development and fostering the creation of remarkable works. Student worksheets (LKPD) serve as self-learning packages that consist of planned and systematic learning experiences aimed at achieving educational objectives. However, based on the researcher's teaching experience, the available learning materials, particularly LKPD, are insufficient to encourage higher-order thinking skills among students. The currently used LKPD are overly simplistic and do not align with the applied learning models, especially the problem-based learning model, thereby failing to support the enhancement of students' critical thinking and collaborative skills.

Collaboration is one of the essential 21st-century skills, prominently featured in the Pancasila Student Profile character, which emphasizes teamwork competence. Observations reveal low collaboration among students, particularly during group problem-solving tasks. This is characterized by inadequate participation, limited opinion sharing, closed-mindedness, difficulty in role distribution, and low motivation and responsibility (Purwasih et al., 2021; Ratminingsih et al., 2021). Addressing these issues requires a problem-based learning process supported by appropriate and interactive LKPD.

Critical thinking skills are equally vital in facing global challenges. Critical thinking involves reasoning aimed at gathering information to make reasonable decisions and forming justified beliefs (Sufajar & Qosyim, 2022). Science learning, which emphasizes discovery aspects, benefits from using LKPD to help students independently find concepts (Ariani & Meutiawati, 2020).

To develop both critical thinking and collaborative skills, it is necessary to design LKPD based on problem-solving learning models. Effective LKPD should foster students' abilities through critical thinking and collaboration, aiding them in understanding and expressing learned concepts. Utilizing LKPD as learning guides can significantly enhance the learning process (Melindawati, 2021).

However, current LKPD used in schools are often unappealing, with limited space for answers and unattractive designs. They are generally incomplete and lack adequate supporting images, necessitating teachers to create their own LKPD to implement effective and efficient learning activities. Integrating critical thinking and collaborative skills into LKPD can help students practice scientific skills and attitudes (Nurcahyo et al., 2018).

Implementing problem-based learning LKPD focuses on critical thinking and collaboration skills, aligning with the ADDIE development model, which provides a structured approach to identifying learning needs and ensuring that all activities meet educational objectives. Each stage in the ADDIE model involves careful consideration, reflection, and feedback to ensure continuous improvement (Fortune et al., 2021).

The ADDIE development model, combined with problem-based learning, positions the teacher as a facilitator who assists students in finding information through deduction and construction. Problem-based collaborative learning, an approach integrating problem-solving with collaboration skills, is highly effective in teaching these essential competencies (Ariyanto et al., 2019).

In the development of problem-based learning LKPD, students are not initially given information; instead, they discover information through guided instructions in the LKPD, aiming to find answers to posed questions (Nismidawati et al., 2022; Irawan, 2017). Previous research indicates that critical thinking and collaboration skills can be significantly enhanced using well-designed LKPD. The current school conditions show that existing LKPD do not adequately prepare students for critical thinking and collaboration, as they primarily contain simple questions without fostering deeper engagement.

Therefore, it is necessary to develop LKPD that align with the students' characteristics and school environment, promoting activities that enhance critical thinking and collaboration skills. Previous studies have demonstrated that problem-based learning LKPD can improve students' critical thinking (Abdillah & Astuti, 2021). Additionally, Cahya et al. (2023) found that such LKPD can enhance collaboration skills and learning outcomes, evidenced by improved average student scores. Based on the explanation above, this paper aims to describe the validity, practicality and effectiveness of problem based learning based LKPD on pressure material in SMPN 7 Menui Satap.

Methods

The type of research conducted is developmental research using the ADDIE development model. In this developmental research, the product generated is a student worksheet (LKPD) for the science subject focusing on the topic of pressure. This research was conducted in December during the odd semester of the 2023/2024 academic year. The research subjects in this development were a science teacher and 15 students at SMP Negeri 7 Menui Satap. 15 students consist of 8 boys and 7 girls with average age are ($M= 14.26$) years old. All meetings using LKPD and problem-based learning models in classroom learning were held in 5 meetings on learning material about pressure.

The research procedure followed the product development procedure with the ADDIE model, detailed as follows:

Analysis

The first stage, analysis, was conducted through observations during the science learning process and interviews with the subject teacher, based on the researcher's experience, which indicated a lack of LKPD development in science learning. Next, the material analysis stage involved observing the lesson plans (RPP) used to ensure that the materials in the developed learning tools aligned with the learning indicators to be achieved by the students. This was based on observations and the researcher's experience at SMP Negeri 7 Menui Satap.

Design

The second stage of the ADDIE model, design, involved designing the product according to the needs of the students and the learning materials.

Development

The third stage of this development is the development stage, following the design of the previously generated product. This involved developing the learning tools according to the LKPD product, analyzing the product using instruments created for the validation sheet. Validation was performed by media experts and material experts. Revisions were made after the validation test. Several aspects developed in the LKPD include:
1) Design Specifications: Previously, no LKPD oriented towards the problem-based learning model containing science/physics materials was available at SMP Negeri 7 Menui Satap. The developed LKPD was designed to be more engaging for students.
2) Content: The LKPD includes the title, subject, semester, place, learning instructions, competencies to be achieved, indicators, supporting information, tasks, work steps, and assessment.
3) Validation: The LKPD was validated by experts at the Postgraduate program of Untad. Validators conducted the product validation by filling out the provided questionnaire. Validators were also asked to provide feedback to improve the quality of the developed product as a basis for product trials with students.

Implementation

The fourth stage involves implementing the product design that has been developed. The developed product was directly applied to the learning process in the classroom at SMP Negeri 7 Menui Satap. Following this, the responses of the users, including students and the science/physics teacher, and the learning outcomes after using the developed product were reviewed to achieve the expected research objectives. The researcher served as an observer with the assistance of the classroom teacher to apply the developed product. The science/physics teacher and the students were asked to fill out questionnaires to gather feedback on the developed LKPD. In this stage, the test subjects were given assessment questionnaires for the product, resulting in quantitative data.

Evaluation

The fifth stage, evaluation, is a process of obtaining feedback from various parties on the LKPD that has been created and developed. To understand the users' responses to the developed LKPD, questionnaires were administered to the science/physics teacher and the students. Suggestions from the science/physics teacher and students were analyzed and revisions were made until a final product suitable for classroom learning at SMP Negeri 7 Menui Satap was produced.

Data Collection

During the data collection stage, data were gathered using research instruments. The instruments used in this study consisted of two types. The first instrument was the learning tool instrument, which included the syllabus, lesson plans (RPP), and student worksheets (LKPD). The second instrument supported the research, such as expert validation questionnaires to assess product development on likert scale (1-5), implementation questionnaires to assess the practicality of the product with likert scale (1-4), essay tests to measure students' critical thinking skills with 7 essay questions and observation questionnaires for collaboration skills assessed on a Likert scale (1-4) with 10 statement items.

Data Analysis

After the research data were obtained, data analysis was conducted. The analysis was based on the validity, practicality, and effectiveness of the learning tools, as described below:

1) Validity Analysis: The validation sheets assessed by experts were analyzed for the validity level of the developed LKPD, calculated based on the visible descriptors and then compared according to the validity category. The category are presented in Tabel 1.

Tabel 1. Criteria of validity

Average	Category
4,21 -- 5,00	Very Valid
3,41 -- 4,20	Valid
2,61 -- 3,40	Fairly Valid
1,81 -- 2,60	Invalid
1,01 -- 1,80	Very Invalid

(Irsalina & Dwiningsih, 2019)

2) Practicality Analysis: The questionnaire data given to teachers and students were analyzed to measure the practicality of the developed LKPD. The questionnaire data were calculated based on the visible descriptors. The data from the questionnaires are calculated based on the descriptors shown in Table 2.

Tabel 2. Category of practicality level LKPD

Percentage (%)	Category
0 - 20	Impractical
21 - 40	Not Very Practical
41 - 60	Fairly Practical
61 - 80	Practical
81 - 100	Very Practical

3) Effectiveness Analysis: The effectiveness of the developed LKPD uses data from observations of students' collaboration skills, assessed on a Likert scale (1-4) with 10 statement items. The results are interpreted according to the categories in Table 3.

Table 3. Criteria of collaboration skills

Criteria	Percentage (%)
Very High	81-100
High	61-80
Moderate	41-60
Low	21-40
Very Low	0-20

(Octaviana et al, 2022)

The effectiveness of the LKPD in enhancing critical thinking skills is determined from essay test data with seven questions. The results are then analyzed using the t-test and effect size test. The t-test is used to compare the scores before and after the treatment, while the effect size test provides an overview of the score improvement between the pretest and posttest. This testing is conducted using statistics software, with the classification of effect size categorized in Table 4.

Tabel 4. Classification of *effect size*

Percentage (%)	Category
86 - 100	Very Good (A)
71 - 85	Good (B)
56 - 70	Enough (C)
0 - 55	Poor (D)

(Cahya, 2023)

Results and Discussion

The LKPD was designed based on core competencies, basic competencies, competency achievement indicators, and included the syntax of the Problem Based Learning model, along with concept maps, usage instructions, practice questions, and a bibliography. The developed LKPD is expected to assist students in learning. According to Saraswati et al. (2021), LKPD can enhance understanding of learning materials and foster students' creativity in optimizing problem-solving abilities.

Before entering the ADDIE development stage, the instruments that had been validated by validators and declared valid were used in the learning process. The results of the instrument validation are presented in Table 4. Additionally, Table 5 presents suggestions and improvements made to the instruments.

In the RPP validation, there are three (3) aspects of assessment: the RPP format, learning activities, and the language used in writing the RPP. The validation results by Validator 1 obtained an average score of (M= 4.94), a percentage of 98.82% in the very valid category, and Validator 2 obtained an average score of (M= 4.59), a percentage of 91.76% in the very valid category. The validated RPP was categorized as valid, but improvements were still needed according to the problem based learning syntax based on the improvement suggestions given by both validators. Once these improvements were made, the RPP was ready for use in learning.

Table 4. Result of validation instruments

Instruments	Description	Validator 1	Validator 2
Lesson Plan (RPP)	Total Score	84	78
	Mean	4.94	4.59
	Percentage (%)	98.82	91.76
	Interpretation	**Very Valid**	**Very Valid**
Collaboration Skills Observation Sheet	Total Score	96	90
	Mean	4.80	4.50
	Percentage (%)	96	90
	Interpretation	**Very Valid**	**Very Valid**
Critical Thinking Skills Test	Total Score	66	64
	Mean	4.71	4.57
	Percentage (%)	94.29	91.43
	Interpretation	**Very Valid**	**Very Valid**

Table 5. Recommendations and improvements

Aspect	Improvement Suggestions	Improvement Results
Lesson Plan (RPP)	• Adapt to PBL syntax	• Has been adapted to the PBL model
	• Describe it systematically	• It has been described systematically
Colaboration Skills	• Adjust to a more communicative editorial team	• It has been adapted to a more communicative editorial team
Observation Sheet	• Improve Writing	• The writing has been corrected
	• Editing indicators on the observation sheet	• Have redacted the indicators on the observation sheet
Critical Thinking Skills Test	• Adjust to the aspect being researched	• Has been adapted to the aspects studiedi
	• Improve your writing	• The writing has been corrected
	• Create sentences that reflect the indicators	• A sentence has been created that reflects the indicator

In the validation of the collaborative skills observation sheet, there are three (3) assessment indicators: collaborative attitude and character, active collaborative behavior, and collaborative skills. This assessment aims to determine the clarity of each statement and the filling instructions on the observation sheet, the accuracy between the statement and the expected answer, and the alignment of the statement with the aspects to be achieved.

The validation results by Validator 1 obtained an average score of (M= 4.80), a percentage of 96% in the very valid category, and Validator 2 obtained an average score of (M= 4.50), a percentage of 90% in the very valid category. However, improvements were still necessary based on the suggestions provided by the validator. After making improvements based on the suggestions from both validators, the observation sheet was ready for use. These improvements were made to produce a good and suitable observation sheet for use in learning.

In the validation of the critical thinking skills test, there are two (2) aspects of assessment: the alignment of the questions with critical thinking and higher-order thinking skills (HOTS) indicators and the alignment of the questions with the answer key. This critical thinking skills test validation was conducted by two expert validators. The validation results by Validator 1 obtained an average score of (M= 4.71), a percentage of 94.29% in the very valid category, and Validator 2 obtained an average score of (M= 4.57, a percentage of 91.43% in the very valid category. However, improvements were still needed based on the suggestions provided by the validators. After making improvements based on the suggestions from both validators, the critical thinking skills test was ready for use in learning.

In this study, the instruments used had been validated by expert validators. This study employed the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation.

Analysis
(1) Curriculum analysis
The material developed in the LKPD based on Problem Based Learning is pressure material. This analysis was obtained based on the review of curriculum documents at SMPN 7 Menui Satap. The curriculum used in class VIII is the 2013 curriculum. The development process of the LKPD began with the analysis stage, which includes curriculum analysis, student analysis, material analysis, and learning objective analysis. The purpose of curriculum analysis is to determine the curriculum used in class VIII at SMP Negeri 7 Menui Satap. By analyzing the

curriculum, the competencies that will be achieved in the material to be used can be identified.

(2) Student analysis
The results of the characteristic analysis of class VIII students at SMPN 7 Menui Satap are listed in Table 6.

Table 6. Results of the student characteristics analysis

Indicator	Result Analysis
Characteristic	• low student collaboration in group discussions
	• Student learning motivation is low
	• Problem solving skills are lacking
	• Less active in the learning process
Content	• Students are less interested in taking science lessons
Material	• Students have difficulty in working on hots-based questions
Learning Style	• lack of student concentration during the learning process

Student analysis is an effort to understand the characteristics or learning styles, abilities, skills, learning styles, and interests related to learning. In this study, student analysis was obtained from interviews with several teacher colleagues. The student analysis results indicated a lack of learning interest, low learning motivation, low problem-solving skills, lack of active participation in learning, low interest in science subjects, and a preference for media and practical activities in learning.

This aligns with the opinions of Rizani et al. (2022) and Melindawati (2021), who state that understanding the characteristics of students who will undergo the learning process is essential for teachers to facilitate the determination of learning objectives, methods, media, and materials to be used. The learning process will proceed smoothly if the teacher understands the students' characteristics well. Analyzing the initial characteristics of students is an effort to understand their demands, talents, interests, needs, and concerns related to specific learning. Therefore, a solution in the form of engaging learning media is needed to attract students' interest in learning (Sari et al., 2020).

(3) Material analyisis
The next procedure is the material analysis, conducted by observing the curriculum and syllabus used, ensuring that the material included in the developed LKPD aligns with the learning outcomes that students need to achieve. The results of the material analysis can be seen in Table 7.

Material analysis is carried out to observe the curriculum and syllabus used so that the material in the

Problem Based Learning LKPD being developed aligns with the learning outcomes that students need to achieve and allows for the implementation of the steps of the problem-based learning model. The results of the material analysis revealed that in class VIII, there are two basic competencies (KDs) that enable the development of Problem Based Learning LKPD. These basic competencies are KD 3.6 "Analyzing the pressure of solid substances, the pressure of liquids, and the pressure of gases, including in everyday life" and KD 4.6 "Presenting the results of discussions utilizing pressure in everyday life."

Table 7. Results of material analysis

No	Result Analysis
1	In class VIII there are two basic competencies (KD) which make it possible to develop LKPD based on Problem Based Learning.
2	Basic competencies in pressure material are suitable for use in Problem Based Learning model learning.
3	Pressure material has sub-topics that make it possible to train students' collaboration and critical thinking skills

The pressure material has several sub-materials that allow students to conduct simple experiments. This can be utilized to measure collaboration skills through group discussions and students' critical thinking skills through problem-solving. From the material aspect, the pressure material requires a deeper and more contextual understanding, necessitating further elaboration to make the material easier to understand. In the learning process, besides mastering the material, students are also required to master 21st-century skills such as critical thinking skills and collaboration skills (Septikasari, 2018).

Design

In this phase, the initial design of the Problem-Based Learning (PBL) LKPD product to be implemented is created by the researcher. The LKPD consists of three main sections: the introductory section, the main section, and the concluding section.

1) Introductory Section: This section of the LKPD includes the cover page, preface, table of contents, concept map, steps of the problem-based learning model, syllabus, core competencies, basic competencies, competency achievement indicators, learning objectives, and usage instructions.

2) Main Section: The main section of the LKPD contains three parts: LKPD 1 (Pressure of solid substances), LKPD 2 (Pressure of liquids), and LKPD 3 (Pressure of gases).

3) Concluding Section: This section includes practice questions and references.

In this phase, the problem-based learning LKPD on pressure material, which consists of three parts, is organized by the researcher. The introductory section of the LKPD includes the cover page, preface, table of contents, concept map, steps of the problem-based learning model, syllabus, core competencies, basic competencies, competency achievement indicators, learning objectives, and usage instructions. This section covers general information about the developed LKPD. The main section of the LKPD contains LKPD 1 (Pressure of solid substances), LKPD 2 (Pressure of liquids), and LKPD 3 (Pressure of gases). This section aligns with the

steps of the problem-based learning model. The concluding section contains practice questions and references.

Development

This stage is a continuation of the design phase aimed at producing High Order Thinking Skills (HOTS) LKPD with a problem-based learning model on magnetism material. In this phase, validation of supporting instruments used in this research is also carried out, including the lesson plan (RPP), observation sheet of collaborative skills, and critical thinking skills test. These instruments must first be validated by expert lecturers before use. The results of this stage are as follows:

(1) **LKPD Validation**

The LKPD developed is validated by expert validators. The purpose of this validation is to measure and evaluate the validity level of the developed product. The validation instrument uses a Likert scale. The results of the LKPD validation analysis can be seen in Table 8,

Table 8. Result of validation instruments

Description	Validator 1	Validator 2
Total Score	133	129
Mean	4.75	4.61
Percentage (%)	95	92.14
Interpretation	**Very Valid**	**Very Valid**

Recommendations and improvements were made to the LKPD to enhance its alignment with the local environment and culture. One key suggestion for improvement was to adapt the LKPD content to better reflect the environment and culture of the local community. Following this recommendation, the LKPD was revised and adjusted to ensure that it is more relevant and engaging for the students, taking into account the local context.

After being assessed by the validator, the LKPD underwent necessary revisions and improvements. Subsequently, the validation stage was conducted by two validators, resulting in a classification of highly valid. Despite this, further adjustments were made based on the feedback provided by the validators, ensuring the LKPD's effectiveness and alignment with educational goals.

LKPD validation in this study was conducted by two expert validators. Based on the validation results, validator 1 scored an average of 4.75 with a percentage of 95.00% in the "very valid" category, and validator 2 scored an average of (M= 4.61) with a percentage of 92.14%, also in the "very valid" category. These average scores are derived from four assessment aspects: learning aspect, content material, conformity of LKPD with problem-based learning steps, and the suitability of LKPD. Although the validated LKPD falls into the valid category, improvements are still needed based on the suggestions provided by both validators.

(1) Teacher assessment

The next procedure involves the assessment of the LKPD by three science teachers. The purpose of this teacher assessment is to determine the feasibility of the LKPD for use in teaching. The results of the teacher assessment analysis can be seen in Table 9.

Table 9. Teacher assessment analysis result

Description	Evaluator 1	Evaluator 2	Evaluator 3
Total Score	37	38	35
Mean	3.70	3.80	3.50
Percentage (%)	92.50	95.00	87.50

(2) Individual and small group testing

Individual testing was conducted by 5 students, while small group testing involved 15 students. The results of the analysis from individual and small group testing can be seen in Table 10.

Table 10. Individual and small group test analysis results

Test	Description	Result
Individual	Total Score	199
	Mean	3.69
	Percentage (%)	92.13
	Interpretation	**Suitable for use**
Small Gorup	Total Score	196
	Mean	3.63
	Percentage (%)	90.74
	Interpretation	**Suitable for use**

Next is the teacher assessment, individual testing, and small group testing of the developed LKPD. The goal is to determine the suitability of the LKPD for teaching. Based on the teacher assessment, it was found that assessor 1 obtained an average score of ($M=$ 3.70), percentage 92.50%, assessor 2 obtained an average score of ($M=$ 3.80), percentage 95%, and assessor 3 obtained an average score of ($M=$ 3.50), percentage 87.50%. In the individual test, an average score of ($M=$ 3.69), percentage 92.13%, was obtained, and in the small group test, an average score of ($M=$ 3.63), percentage 90.74%, was obtained. Based on these results, it can be concluded that the LKPD is suitable for use in teaching.

Implementation

The development of the problem based learning-based student worksheets (LKPD) on pressure has been validated by experts, followed by the next stage, where the LKPD product was piloted with a group of students. This trial involved one class, specifically the eighth grade at SMPN 7 Menui Satap, consisting of 15 students. The students engaged in learning activities using the developed product and subsequently underwent a series of tests aimed at assessing the product's effectiveness. The practicality of the development product was evaluated by teachers using a response questionnaire.

(1) Practicality of the LKPD

The practicality of the LKPD was assessed based on teacher responses during the classroom learning process. The results of the LKPD practicality assessment are presented in Table 11.

Table 11. The practicality of LKPD result

Aspect	Average	Catagory
Knowledge Construction	3.75	Practical
Design	3.83	Practical
Language	4.00	Practical
PBL Activities	3.73	Practical
Conclusion	**3.82**	**Practical**

The practicality of the LKPD was evaluated through teacher responses to the developed product during the implemented learning activities. Based on the analysis of teacher responses, an average score of ($M=$ 3.82) was obtained, indicating practicality. Overall, this demonstrates that the problem based learning-based LKPD is practical for use in teaching. The teacher response questionnaire included evaluation across four aspects: knowledge construction, design, language, and problem-based learning activities.

(2) The effectiveness of LKPD collaboration skills

Students' collaboration skills were assessed using an observation sheet comprising 10 evaluation aspects, validated by expert validators. The assessment of collaboration skills involved comparing the overall percentage scores obtained by students in the experimental group and the control group from the first to the last session. The results of students' collaboration skills data are presented in Table 12.

Table 12. Description of students collaboration skills score

Indicator	Meeting		
	1	2	3
Total Score	389	470	551
Mean	2.59	3.13	3.67
Percentage (%)	**64.75**	**78.25**	**91.75**

The effectiveness of the problem based learning-based student worksheets (LKPD) on students' collaboration skills was measured using the observation sheet, which includes 10 assessment aspects. The observation sheet was employed to evaluate students' skill outcomes throughout three sessions of the learning process. The assessment results in the observation sheet were calculated to obtain average scores and overall percentages.

The analysis revealed that in the first session, the percentage was 64.75%, increasing to 78.25% in the second session, and reaching a higher percentage of 91.75% in the third session, categorized as very high. The analysis of students' collaboration skills showed improvement from the first to the third session. This indicates that the use of problem based learning-based student worksheets (LKPD) with problem based learning (PBL) instructional models on the topic of pressure is effective. This research aligns with Sufajar and Qosyim (2022) and Sunbanu et al. (2019), demonstrating that the developed product is more effective in enhancing students' collaboration skills compared to conventional LKPD used in control classes.

Critical thingking skills

Students' critical thinking skills were measured based on the results of pre-tests and post-tests on critical thinking skills, comprising seven essay questions. The findings provide a description of the critical thinking skills scores for the students. The sample size for both the pre-test and post-test was 30 students. The mean score for the pre-test was 43, whereas the mean score for the post-test significantly increased to 81. Both the pre-test and post-test had an ideal score of 100. The t-test result showed a significance (2-tailed) value of 0.022, indicating a

statistically significant improvement in the scores. Additionally, the Cohen's d value was 0.88, which is interpreted as a huge effect.

The effect size test in eighth-grade classes yielded a Cohen's d score of 0.88, categorized as a high effect size. This indicates that the use of problem-based learning-based student worksheets (LKPD) on the topic of pressure is more effective in improving students' critical thinking skills compared to conventional LKPD. This finding is consistent with previous studies by Akhdinirwanto et al. (2020) and Lakusa et al. (2022), suggesting that Problem-based learning-based student worksheets (LKPD) can activate students to practice higher-order thinking skills in learning. Developing problem-based learning-based student worksheets (LKPD) will aid in enhancing students' thinking abilities.

Evaluation

The final stage of developing these Problem Based Learning-based Student Worksheets (LKPD) involves evaluating their suitability for students in understanding the topic of pressure. The success criteria for this LKPD development are based on the feedback provided by students through the questionnaire they completed. The analysis of students' feedback obtained from the questionnaire responses is presented in Table 13.

Table 13. Results of student response questionnaire analysis

Description	Result
Total Score	559
Mean	3,73
Percentage (%)	93,25

Evaluation is conducted both formatively and summatively. Formative evaluation is carried out at each stage of the ADDIE model development. During the analysis stage, evaluations such as curriculum analysis, student analysis, material analysis, and learning objective analysis are performed to align with the LKPD product. Design stage evaluation involves adapting the product to meet higher order thinking skills (HOTS) indicators and problem-based learning models. Development stage evaluation includes making improvements based on validator feedback.

During the implementation stage, evaluation occurs by observing difficulties faced by students during classroom trials. After completing each stage of development, summative evaluation is conducted to assess the final LKPD product after testing and validation. The success criteria for this LKPD development are assessed based on feedback or responses from students who completed the provided questionnaire (Lisa et al., 2023). The questionnaire covers several assessment aspects such as interest, design, and presentation of LKPD content. Based on the analysis of student questionnaire responses, an 88.83% satisfaction rate was obtained, categorized as practical. This indicates that problem based learning-based student worksheets (LKPD) on the topic of pressure are practical for use in learning, effectively enhancing students' collaboration and critical thinking skills at SMPN 7 Menui Satap.

Conclusions

Based on the research findings, it can be concluded that problem based learning-based student worksheets (LKPD) on the topic of pressure developed to enhance collaboration and critical thinking skills among students at SMPN 7 Menui Satap achieved a suitability rating of 93.57%, categorized as highly valid. Moreover, these LKPD are practical for use in learning, as evidenced by the average score of (M= 3.82) from teacher feedback, categorized as practical. The effectiveness of these LKPD in improving students' collaboration skills is evident from the increasing percentages observed in each session: 64.75% in the first session, 78.25% in the second session, and 91.75% in the third session, categorized as very high. Additionally, these LKPD are quite effective in enhancing students' critical thinking skills, with an effect size analysis yielding a Cohen's d value of 0.88, categorized as a high effect size.

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Conflict of interest

The authors declares that there is no conflict of interest in this research. All parties involved have given their consent and contributed without any bias or influence that could affect the research results.

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