International Journal of Education, Humaniora, and Social Studies
Vol. 1, No. 2, pp. 45-52, 2024
e-ISSN 3032-1271 | p-ISSN 3032-4467
https://journal.dpipublish.com/index.php/ijehss/

DEVELOPMENT OF LKPD ON PROJECT-BASED LEARNING TO IMPROVE SCIENCE PROCESS SKILLS AND COLLABORATION SKILLS FOR JUNIOR HIGH SCHOOL STUDENTS

Harin Pratiwi, *Ratman, Daud K. Walanda, Darsikin & Nurasyah D. Napitupulu
Science Education/Postgraduate – Universitas Tadulako, Palu – Indonesia 94119

Received 16 July 2024 | Revised 12 August 2024 | Accepted 27 August 2024
doi: 10.63895/j30321271.2024.v1.i2.pp45-52

Abstract

This research is an R&D approach using the ADDIE model which consists of five main stages: analysis, design, development, implementation and evaluation. The aim of the research is to determine the validity, practicality and effectiveness, as well as investigate the application of PjBL-based LKPD to students' science process and collaboration skills at SMPN 3 Bumi Raya Satap. Data collection techniques included interviews, documentation, validation, surveys, observation to measure collaboration skills, and written tests to examine science process skills. Research instruments included interview guides, teacher and student response questionnaires, collaboration skills observation sheets, and science process skills tests. The results of data analysis showed that the PjBL-based LKPD was retrieved very valid with a score of 3.36, very practical with a score of 4.46, and effective with an effect size (d = 0.84) categorized as having a large influence. The implementation of PJBL-based LKPD has a big influence in improving science process skills (d = 0.97) and a moderate influence on improving collaboration skills (d = 0.32). In conclusion, PjBL-based LKPD has a significant positive impact on improving students' science process and collaboration skills.

Keywords: LKPD, Project-based learning, science process skills, student collaboration skills

Email corresponding author: ratmanut@gmail.com
How to cite: Pratiwi, H., Ratman, Walanda, D. K., Darsikin, & Napitupulu, N. D. (2024). Development of LKPD on project based learning to improve science process skills and collaboration skills for junior high school students. *International Journal of Education, Humaniora, and Social Studies*, *1*(2), 45-52.

Introduction

The teaching and learning process in schools is crucial for building students' skills, especially in the 21st century, where communication, collaboration, critical thinking, and creativity are essential. These fundamental skills are integrated into the core studies and themes to equip students with problem-solving abilities across various fields of science (P21, 2015). The modern educational landscape demands that students are not only knowledgeable but also equipped with the skills to navigate complex problems and work collaboratively in diverse settings.

Science process skills and collaboration skills are critical dimensions in science education, supporting the vision of the 2013 Curriculum, which aims to develop students' attitudes, knowledge, and skills. However, these skills are not yet optimized in the current school learning processes. Despite the curriculum's emphasis on holistic development, many schools still struggle to effectively integrate these skills into their teaching methods. Project-based learning (PjBL) models have been shown to improve these skills effectively (Dwiyanti & Rosana, 2020; Sagala *et al.*, 2020). Collaboration, in particular, trains students to work together to find solutions, but despite good achievements in the cognitive domain, there is still a need to enhance cognitive thinking skills to foster creativity (Malawati & Sahyar, 2016). This gap highlights the need for innovative teaching strategies that can bridge the divide between theoretical knowledge and practical application.

Developing science process skills involves nurturing basic skills such as scientific attitudes and problem-solving abilities. These skills help students become creative, competitive, innovative, and open to criticism in the global community. The process skills approach encourages students to discover facts and construct concepts and theories, emphasizing logical thinking and problem-solving as essential preparations for real-life situations (Waluyo & Nuraini, 2021). This approach aligns with the global shift towards inquiry-based learning, where students are active participants in their educational journey, engaging in hands-on activities that promote deeper understanding and retention of knowledge.

Effective teaching requires teachers to map students' abilities and develop learning tools that guide them in enhancing their reasoning, science process skills, and collaboration skills (Redhana, 2019). Student worksheets (LKPD) tailored to students' characteristics and integrated with relevant material are vital in this process. The contextualization of material in LKPDs must align with learning models that promote independent and collaborative product creation. Project-based learning (PjBL) is one such model, aimed at improving students' logical thinking abilities through project completion guided by well-designed LKPDs, enhancing 21st-century skills like science process skills and collaboration.

Observations during teaching have shown that despite practice questions given at the end of lessons, many students struggle to complete them, indicating low science process and collaboration skills (Janah *et al.*, 2018). This suggests that students are not effectively finding facts, building concepts, or establishing theories in their learning. Furthermore, collaboration among students is insufficiently developed. These observations underscore the importance of revisiting and revising the tools and methods employed in classrooms to better support student learning outcomes.

The limitations of supporting materials, particularly LKPDs, further exacerbate this issue. Existing learning tools are simple and unsuitable for applied learning models, especially those fostering independent, collaborative work. This inadequacy hampers the improvement of students' science process and collaboration skills in producing desired outcomes. The current LKPDs often lack engaging content and structured activities that stimulate higher-order thinking and collaborative problem-solving, leading to a reliance on rote memorization and passive learning.

To address these challenges, this research aims to develop LKPDs using the project-based learning (PjBL) model within the ADDIE learning development framework. The ADDIE model encompasses reviewing previous research on product validity, product development, testing, and iterative refinement based on feedback, ensuring objectivity and effectiveness in the final product. This structured approach allows for continuous improvement and alignment with educational standards and student needs. Therefore, developing LKPD-oriented learning tools using the PjBL model through the ADDIE development technique is necessary to improve the science process skills and collaboration skills of eighth-grade students at SMP Negeri 3 Bumi Raya Satap.

This study aims to develop LKPDs that enhance students' science process skills and collaboration skills by applying the project-based learning (PjBL) model through the ADDIE development technique, focusing on eighth-grade students at SMP Negeri 3 Bumi Raya Satap. By implementing these revised LKPDs, we seek to create a more engaging and effective learning environment that fosters critical thinking, collaboration, and practical problem-solving skills, preparing students for future academic and professional success.

Methods

This research is a development study (Development & Research) limited to product development, product validation, practicality testing, and effectiveness testing of product usage. The subject of this research is the development of LKPD based on the PjBL learning model. Various support were involved in this research as test subjects, namely material experts, teachers, and 18 students from SMPN 3 Bumi Raya Satap. The research subjects were all class VIII students consisting of 10 male and 8 female with an average age of 14 years. This development research employed the ADDIE development model steps analysis, design, development, implementation, evaluation (Branch, 2010).

Analysis

In this initial stage, observations were conducted during the learning process of science subjects in the classroom, along with interviews with several students and science teachers. The interviews aimed to gather information regarding the learning models used and preferred by students, students' responses to the learning process, and the challenges faced by teachers and students. The information from observations and interviews was then analyzed to determine the appropriate material. In this research, the topic of Pressure of Substances and Its applications in daily life was chosen, focusing on the subtopics of Hydrostatic Pressure, Archimedes' Law, and Pascal's Law.

Design

The second stage of the ADDIE model is the design phase, where the LKPD (Student Worksheets) are designed according to the analysis results from the previous stage.

Development

This third stage involves further development of the previous product, specifically the development of LKPD using Canva application with additional images from the internet. The product was analyzed using validation instruments and its feasibility was tested through validation by experts. Revisions were made based on the validation test results. The development includes:

1) Didactic Specifications: Developing LKPD oriented towards a project-based learning model containing science materials for SMP Negeri 3 Bumi Raya Satap, with a more attractive appearance.
2) Construction Aspect: Using appropriate language, clear sentence structure, clear activities, avoiding overly open questions, not referring to sources beyond students' capabilities, providing enough space for writing or drawing, and using simple and short sentences. The teaching materials were validated by experts at the Postgraduate Program of Untad through questionnaires and feedback for improvement.
3) Technical Aspect: Involving appearance, text consistency, and appropriate use of images.

The LKPD product was tested in a small class at another school with the same grade level. Feedback from teachers and students was collected through questionnaires to determine the practicality of the LKPD. Suggestions from science teachers and students were analyzed and revisions were made to produce a final product suitable for use in the eighth grade at SMP Negeri 3 Bumi Raya Satap. The effectiveness test was conducted by comparing the pretest and posttest learning outcomes of students in the small class.

Implementation

After the product was deemed feasible in the small class trial, it was implemented in the learning process for eighth-grade students at SMP Negeri 3 Bumi Raya Satap using a one-group pretest-posttest design and observation sheets over five meetings. A pretest was conducted before the first meeting to evaluate the students' science process skills. The first meeting (3 × 40 minutes) involved distributing and working on the LKPD. The second to fourth meetings (2-3 × 40 minutes per meeting) focused on practical activities and editing images/videos for each LKPD. The fifth meeting (3 × 40 minutes) was used for assessment and evaluation of the three LKPDs. A posttest was conducted after the learning process to measure the improvement in students' science process skills. Throughout the process, students' collaboration skills were assessed using observation sheets.

Evaluation

In the fifth stage, evaluation was conducted to determine the quality of the developed LKPD. The quality of the LKPD was assessed based on user feedback from both science teachers and students.

Data Collection

Data collection in this research was conducted using several techniques: interviews for initial data, documentation for written objects, expert validation, surveys for product practicality, and observations for students' collaboration skills before and after using the developed LKPD.

In the research trial, various instruments were used to gather the necessary data. First, interview guidelines were employed to explore teachers' and students' views on the Project-Based Learning (PJBL) based LKPD. Next, a response questionnaire is used to assess the implementation of learning from the perspective of teachers and students using a Likert scale (1-5). Direct observations by the researcher were conducted using observation sheets to monitor students' collaboration skills which consisted of 10 statements items. Finally, written essay tests were administered to students to measure their understanding of science process skills with 10 item of essay test. All instruments were meticulously prepared to ensure relevant and valid data according to the research objectives.

Data Analysis

Data analysis was performed based on the validity, practicality, and effectiveness of the learning tools, as outlined below:

1) Validity Analysis: The validated sheets were calculated based on the observed descriptors and then compared according to the validity level category.
2) Practicality Analysis: Data from questionnaires given to students and teachers were analyzed to measure the practicality of the developed LKPD. The results from the questionnaires were then calculated based on the observed descriptors.
3) Effectiveness Analysis: The effectiveness of the LKPD product was analyzed using Cohen's effect size (Cohen, 1988). This effectiveness analysis was conducted to determine the feasibility of the LKPD before implementation by taking test results from a small class/trial. The effectiveness of the learning tools in this research included aspects of students' science process skills and collaboration skills.

Students' science process skills were analyzed through tests, namely pretest and posttest questions. The test questions used were essay questions based on science process skills indicators, consisting of 10 questions to assess the level of students' science process skills.

Students' collaboration skills were analyzed through observations before the treatment and after the product application. The assessment of students' activities was conducted using observation sheets made based on the indicators and aspects of collaboration skills to assess the level of students' collaboration skills with the help of subject teachers.

Results and Discussion

This research aimed to produce a valid, practical, and effective LKPD based on project-based learning (PjBL) for the topic of liquid pressure, which would also positively influence students' science process skills and collaboration skills. The result of this research was an LKPD for science learning based on project-based learning (PjBL) on the topic of liquid pressure. The research and development followed the ADDIE model procedure, which includes: 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation.

Analysis

In this stage, an analysis was conducted through observation and interviews. Several key findings were revealed during the science learning process in the eighth grade at SMPN 3 Bumi Raya Satap. The science curriculum used was still the 2013 curriculum, with a predominance of the discovery learning model employed by science teachers and limited use of LKPD from textbooks only. Practicals were conducted without any projects or products being generated, and students showed a lack of interest in physics material. Additionally, structured LKPD was not utilized, resulting in low student engagement and poor science process skills and collaboration. Nevertheless, students preferred direct learning or practical activities, with some showing enthusiasm in this regard.

Challenges faced by teachers included unstable internet access and unexpected power outages, though the school's facilities and infrastructure supported learning activities. The analysis of this data suggested several solutions to improve science learning, including the use of project-based learning (PjBL) models and LKPD, the use of tests to measure students' science process skills, group discussions to enhance collaboration skills, and the utilization of media such as PowerPoint, images, and videos.

Design

In the design stage, the initial draft of the LKPD based on project-based learning (PjBL) was developed, consisting of three main sections. The initial section of the LKPD included the cover page, preface, table of contents, concept map, and usage instructions. The core section of the LKPD comprised three modules, namely Hydrostatic Pressure, Archimedes' Law, and Pascal's Law, each with the identification of basic competencies, indicators, learning objectives, material summaries, and steps for completion according to the PjBL syntax. The final section of the LKPD included practice questions, a product assessment rubric, and a bibliography, refining the product structure aimed at enhancing the learning experience for students in science subjects.

Development

This stage is a continuation of the design phase to produce an LKPD based on project-based learning (PjBL) for the topic of liquid pressure. The LKPD was developed using the Canva application, with the content derived from existing science textbooks at the school and from the internet. Additionally, images used were sourced from the internet. The completed LKPD product was subsequently subjected to feasibility testing, including:

(1) ***Validation result***

The results of the validation of the instruments and LKPD are presented in Table 3. Based on the analysis results presented, it can be understood that the instruments created and the LKPD developed are valid for use in learning and can proceed to the next stage of research.

Table 3. Result of validation instruments

Instruments	Description	Score		Average
		Validator 1	Validator 2	
Lesson Plan (RPP)	RPP Format	4	3.83	3.92
	Content of RPP	3.75	3.25	3.5
	Language	4	3	3.5
	Benefits of RPP	4	4	4
	Average	3.93	3.53	3.67
	Criteria	**Very Valid**	**Very Valid**	**Very Valid**
Student Worksheet (LKPD)	Format of LKPD	3.43	2.86	3.14
	Language	3.67	3.17	3.42
	Content of LKPD	3.4	3.6	3.50
	Design of LKPD	3.6	3.2	3.40
	Average	3.52	3.20	3.36
	Criteria	**Very Valid**	**Very Valid**	**Very Valid**
Science Process Skills Test	Test Content	4	3.1	3.55
	Construct	3.1	2.8	2.95
	Language	3.8	3.3	3.55
	Average	3.63	3.07	3.35
	Criteria	**Very Valid**	**Valid**	**Very Valid**
Collaboration Skills Observation Sheet	Content Suitability	3	3	3
	Construct	4	3	3.5
	Language	4.00	2.67	3.33
	Average	3.67	2.89	3.28
	Interpretation	**Very Valid**	**Valid**	**Very Valid**

The PjBL-based LKPD, which was developed based on the ADDIE development model, is considered feasible for use when it meets the validity requirements. This statement aligns with Mirwanda *et al.* (2022), who stated that the validation of the developed LKPD is necessary to assess whether the LKPD is suitable for use in learning or if there are still errors. According to Kosasih (2021), validation aims to determine the feasibility of the developed product based on expert opinions, ensuring that the product is suitable for use in learning. The validity of the developed LKPD is assessed based on the recapitulation results from two expert validators, which include evaluations of didactic, constructional, and technical requirements. According to Fauziah and Qomariyah (2020), the validation of the developed LKPD considers three requirements: constructional, technical, and didactic. The feasible LKPD criteria, according to Roehati *et al.* (2009), include didactic requirements related to the universal use of the LKPD by students, constructional requirements involving language use, difficulty, and clarity within the LKPD, and technical requirements focusing on writing and image presentation in the LKPD.

From the validation of the three LKPD requirements, the final validation results obtained an overall average score of 3.39 out of a maximum score of 4, categorizing it as very valid for use in learning. This final result also aligns with Mirwanda *et al.* (2022), who stated that the validation conducted by two experts on the product shows that the Project-based learning LKPD is highly feasible for use in the learning process. Although there are aspects of the LKPD feasibility requirements that received imperfect ratings from both validators, overall, the PjBL LKPD received good ratings, making it very valid for use in learning.

The validity of the PJBL-based LKPD is attributed to its meeting all aspects of didactic feasibility assessment, including the LKPD format and language, constructional aspects of the LKPD content, and technical aspects of the LKPD design. These three LKPD feasibility assessments form an inseparable and mutually supportive whole for the perfection of the developed student worksheets. Although the validation data of the developed student worksheets have not reached 100%, the obtained validation results already meet the criteria of highly feasible with some suggestions/inputs from experts (Agusta *et al.*, 2024). Since the three LKPD feasibility requirements were rated very valid, the validity of the PJBL-based LKPD developed using the ADDIE model was achieved.

(2) ***Small-scale test***

In the small-scale testing, an analysis of practicality and effectiveness was conducted.

Practicality testing results:

After the LKPD was deemed valid for use, the next step involved a small-scale test conducted with 8 (eight) students comprising 3 males and 5 females, consisting of 3 high-ability, 3 moderate-ability, and 2 low-ability students. This small-scale test was conducted at a different school, specifically in class VIII of SMPN 1 Bumi Raya. The test was conducted at a different school because SMPN 3 Bumi Raya Satap only has 1 class in VIII grade, and the students there share similar characteristics, specifically in their low skills in scientific processes and collaboration, as those in SMPN 3 Bumi Raya Satap. The results of the practicality analysis in the small-scale test can be seen in Table 4.

Table 4. Results of the practicality analysis in the small-scale test

Description	Average Score	Interpretation
Student Response	4.61	Very Practical
Teacher Response	4.31	Very Practical
Average	**4.46**	**Very Practical**

Another requirement that must be fulfilled for the LKPD to be deemed suitable is the practicality of the developed PjBL-based LKPD. The practicality of the PjBL LKPD was measured through the analysis of data from student response questionnaires and IPA teacher response questionnaires in the small-scale test. This statement aligns with Nurhidayati *et al.* (2023), who stated that small-scale testing is conducted to assess the practicality of the developed Project Based Learning student activity sheets. This is consistent with Roas *et al.* (2024), who analyzed the practicality of teaching materials based on assessments from teachers and students.

The small-scale test was conducted with 8 students to assess the practicality of the developed PjBL LKPD. Both student and teacher response questionnaires consisted of 13 statements each related to design, content presentation, ease of understanding, and language used in the LKPD. The assessment used a Likert scale with response categories: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), and 1 (strongly disagree). This approach is supported by Nurhidayati *et al.* (2023), who conducted small-scale testing to evaluate the practicality of the developed Project Based Learning student activity sheets by collecting questionnaire results and feedback from 5 students. Aspects evaluated in the small-scale test included content quality and objectives, teaching techniques, and learning quality. The practicality questionnaire in the small-scale test comprised 15 question indicators with response alternatives: 5 (very good), 4 (good), 3 (sufficient), 2 (poor), 1 (very poor).

From the analysis of student response questionnaires, an average score of 4.61 was obtained, indicating a category of very practical, and an average score of 4.31 was obtained from IPA teachers. These scores were averaged to achieve an overall score of 4.46, indicating the LKPD based on PjBL developed has a highly practical design that is engaging for students, presents material in a non-boring manner, enhances student enthusiasm for learning, facilitates understanding of the material, and uses clear and easily understandable language.

Effectiveness test results

After the PjBL LKPD was deemed practical, the effectiveness test was conducted by examining the improvement on student learning outcomes in a small group, categorized by its effect size which can be seen in Table 5.

Table 5. The effectiveness analysis results from the small-scale

Description	Pre-Test	Post-Test
Total Score	155	293
Average	19.38	36.63
Effect Size	0.96	
Interpretation	**Huge Effect**	

The effectiveness of the PjBL LKPD was evaluated based on the analysis of the improvement in student learning outcomes in the small-scale test. The analysis results indicated an increase in the average scores of learning outcomes before and after the use of the LKPD, from 19.38 to 36.63. This improvement signifies that the PjBL LKPD is effective for use, with a substantial effect on improving student learning outcomes, indicated by d = 0.96 (large effect).

Implementation

(1) ***Science process skills***

The developed PJBL-based LKPD on the topic of liquid pressure, which has been deemed suitable, proceeds to the next stage: implementation of the LKPD product with the students. Before implementation, an initial test is conducted to assess the students' baseline skills in scientific process skills, while their baseline skills in collaboration are assessed based on evaluations by subject teachers from previous lessons. Students engage in learning activities using the developed product over 5 sessions.

During these 5 sessions, the PjBL LKPD is applied in class, and assessments are conducted using observation sheets to evaluate students' collaboration skills. For scientific process skills, a post-test is administered after implementing the PjBL LKPD in class. The overall results of the students' scientific process skills test for the entire class can be seen in Table 6.

Table 6. The overall results of the students' scientific process skills test for the entire class

Description	Pre-Test	Post-Test
Total Score	275	511
Average	15.28	28.39
SD	2.97	4.30
SDPooled	13,53	
Effect Size	0.97	
Interpretation	**Huge Effect**	

Based on Table 4, the implementation of the PjBL LKPD significantly enhances overall student scientific process skills. The analysis of students' overall scientific process skills test results based on scientific process skills indicators can be viewed in Figure 1.

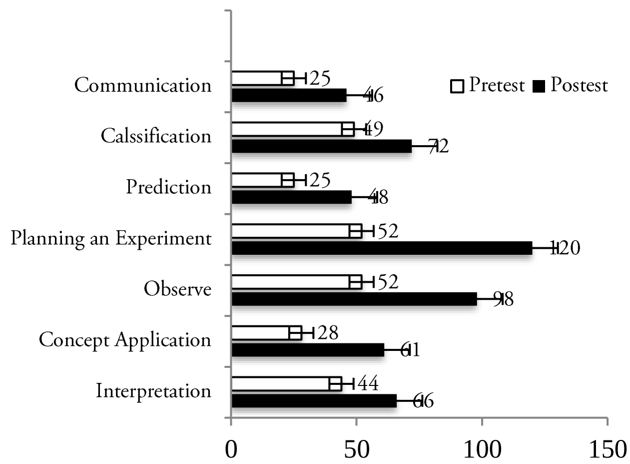

Figure 1. Science process skills test results

Based on the research findings, the implementation of PjBL LKPD has led to a total score increase in each scientific process skills indicator. First, the interpretation indicator, which involves interpreting observations and drawing conclusions from data, saw an increase from 44 to 66. This moderate increase suggests that students have some proficiency in interpreting and drawing conclusions from data but may benefit from continuous training and guidance to further develop this skill. This solution aligns with Wahdah *et al.* (2023), emphasizing the need for continuous learning practices to train students in applying their skills in interpreting data, helping them to interpret presented data effectively.

Next, the application of concepts indicator showed an increase from 28 to 61. This improvement indicates that students are able to apply learned concepts and connect them to real-life situations. According to Purnamasari *et al.* (2021) and Aldi and Ismail (2023), it is crucial to apply scientific process skills in applying concepts so that students can understand and apply learned concepts in new situations, comprehending how these concepts can explain real-life occurrences.

Furthermore, the observation indicator increased from 52 to 98. This significant improvement suggests that students can use observed facts to ascertain the validity of a concept. Yunita and Nurita (2021) also note that observation skills are fundamental and often honed through learning tasks where students are asked to observe material themselves, using senses such as smell, sight, and touch. This observation is directly linked to learning outcomes and can involve both direct observation and images sourced from the internet.

Lastly, the planning experiments indicator showed the highest increase from 66 to 120. This score indicates that students have developed skills in selecting and utilizing tools/materials and can independently create practical work procedures.

The next indicator is the prediction indicator, which saw an increase in score from 25 to 48. The prediction indicator involves students being able to speculate on possible outcomes based on observed patterns. Putri and Prihandono (2022) emphasize that prediction skills involve students estimating possible outcomes based on existing patterns. Despite the increase, the improvement in the prediction indicator remains relatively low. This could be due to students finding difficulty in predicting events related to scientific principles. This assertion is supported by Karamustafaoglu (2011), who suggests that prediction skills are more abstract compared to others, making it challenging for students to respond.

Next, the classification indicator increased from 49 to 72. In this indicator, students are expected to categorize objects based on the principles of science. Most students were able to perform classification tasks, as this indicator represents a fundamental skill in scientific process skills.

The last indicator is communication, which increased from 25 to 44. Communication involves students interpreting experimental data into forms such as graphs, tables, or diagrams. The expectation for communication aligns with Firdaus and Mirawati (2017), who define communication as the ability to articulate concepts and perspectives clearly orally or in writing across various formats (tables, graphs, diagrams, images). Therefore, training and guidance are essential for students as they are not accustomed to communicating data or observations in graphical or diagrammatic forms. This difficulty is also highlighted by Yunita and Nurita (2021), who observed that students often struggle to explain concepts through images, graphs, or tables during learning processes.

Overall, the average scores for the pretest and posttest were 15.28 and 28.39, respectively, indicating an increase in the average score for the eighth-grade class. In conclusion, the implementation of PjBL LKPD had a significant effect on the scientific process skills of eighth-grade students at SMPN 3 Bumi Raya Satap, with an effect size of d = 0.97. This finding is consistent with Setiawan *et al.* (2021), which demonstrated an increase in posttest scores from 63.5 to 83.5 with a moderate N-Gain of 0.54. Additionally, Maryani *et al.* (2017) found that the average N-Gain was 0.70, indicating high effectiveness of PjBL LKPD in improving students' scientific process skills.

(2) ***Students' collaboration skills***

The implementation of PJBL-based LKPD on students' collaboration skills was assessed based on collaboration skill indicators. The overall observation results on students' collaboration skills can be seen in Table 7.

Table 7. The overall observation results on students' collaboration skills

Description	Initial collaboration skills	Collaboration Skills During LKPD Implementation				
		P1	P2	P3	P4	P5
Total Score	216	246	254	276	294	342
Average	12.00	13.67	14.11	15.33	16.33	19.00
SD	2,52					1.03
SD pooled	11,18					
Effect Size	0.63					
Interpretation	***Medium Effect***					

Based on Table 5, an increase in average collaboration skills scores was observed from the initial assessment to the fifth meeting. Starting from initial average collaboration skills score of 12.00, it increased to 13.67 in the first meeting. Subsequently, it increased to 14.11 in the second meeting, further to 15.33 in the third meeting, 16.33 in the fourth meeting, and finally to 19.00 in the fifth meeting. From the data, it can be stated that the implementation of PJBL-based LKPD had a moderate effect on improving overall students' collaboration skills. Further analysis of collaboration skills based on indicators can be found in Table 8.

Based on Table 6, there was an increase in the average total score from 43.20 to 68.40. Additionally, all indicators of science process skills showed improvement at each meeting. The collaboration skill indicators of contribution and time management saw the highest score increase from 43 to 72, with a score increase of 29. This improvement indicates that the use of PjBL LKPD trained students to contribute ideas actively in group discussions and effectively manage time in group tasks (Anantyarta & Sari, 2017). The indicator of working with others showed the lowest score increase from 57 to 72, a 15-point increase. Despite the improvement, this indicator had a lower increase compared to others due to higher initial scores reflecting students' existing proficiency in working with others, such as listening to group members' ideas and aiding in completing group tasks (Purwaaktari, 2015).

Table 8. Result of collaboration skills based on indicators

Indicators	Total Initial Collaboration Skills Score	Total Collaboration Skills Score for Each Meeting					
		P1	P2	P3	P4	P5	Average
Contribution	43	46	51	61	65	72	59
Time Management	43	51	52	55	60	72	58
Problem Solving	37	41	42	45	49	62	44.6
Teamwork	57	64	65	69	70	72	68
Research Techniques	36	44	45	46	50	64	49.8
Average Score	43.20	49.2	51	55.2	58.8	68.4	55.88

Each indicator demonstrated score improvement. Contribution and time management indicators both increased from 43 to 72, indicating active contribution of ideas and timely task completion within groups throughout the learning process. Problem-solving skills improved from 37 to 62, showing students' efforts in finding answers to assigned tasks. Additionally, working with others increased from 57 to 72. Although initially appearing to have the highest score, this indicator experienced the lowest increase, as most students already possessed strong initial skills in working well with others, thereby maximizing their abilities further during learning. This aspect refers to how often students listen to opinions and assist group members. Lastly, investigation techniques improved from 36 to 64, focusing on how students gather and record information from various sources.

Looking at the overall score results for students (class) from the initial to the 5th meeting, there was an increase in the average score from an initial 12.00 to 19.00 in the 5th meeting. This implies that the implementation of PjBL LKPD influenced the collaboration skills of grade VIII students at SMPN 3 Bumi Raya Satap with a moderate effect size of d = 0.63. This finding aligns with Sari *et al.* (2017) who demonstrated a significant increase in students' collaboration skills from "sufficient" to "good" with a significant difference (Sig.) of 0.000 between pre- and post-LKPD scores.

Moreover, this research correlates with Zekri *et al.* (2020) indicated a moderate increase of 31.54% in students' collaboration skills from "sufficient" to "good" using project-based LKPD.

Evaluation

In this stage, an evaluation was conducted to assess the quality of the developed LKPD. Feedback was obtained from subject teachers and students regarding the LKPD that was created and developed. To gauge user responses to the developed LKPD, surveys were administered to both science teachers and students. The responses obtained from teachers and students can be seen in Table 9.

Table 9. Results of student response questionnaire analysis

Description	Result
Average Score	4.14
Interpretation	Very Practical

Based on Table 9, the average student response score was 4.14 out of a maximum score of 5, categorizing it as highly practical. This indicates that the PjBL LKPD is highly practical for use in science education in Grade VIII at SMP Negeri 3 Bumi Raya Satap to enhance students' science process skills and collaboration.

Despite the final assessment indicating that the PjBL LKPD is highly practical, students perceived some shortcomings. These shortcomings may arise because students are not yet familiar with the project-based learning model, where they are required to actively engage in designing their own projects.

Conclusions

Based on the research results, it can be concluded that the PjBL LKPD developed using the ADDIE model is very valid with a score of 3.45. Apart from that, the LKPD was considered very practical with an average score for teachers of 4.31 and students of 4.61. In terms of effectiveness, this LKPD shows a large effect size (d = 1.39), which shows that this approach is effective in improving learning outcomes. Furthermore, the implementation of PjBL LKPD had a very big influence in improving students' science process skills (d = 5.70) and a big influence in improving students' collaboration skills (d = 0.96) in class VIII SMPN 3 Bumi Raya Satap.

Acknowledgment

The authors extend gratitude and appreciation to all parties who supported this research, particularly the Morowali Regency government, the principal of SMPN 3 Bumi Raya Satap, and the students who contributed their time to provide research materials.

References

Agusta, R., Sartika, R. P., Rasmawan, R. (2024). Pengembangan lembar kerja peserta didik zat pengawet makanan berbasis project based learning. *Jurnal Ilmiah Universitas Batanghari Jami, 24*(2), 1246-1253.

Aldi, S., & Ismail. (2023). *Keterampilan proses sains panduan praktis untuk melatih kemampuan berpikir tingkat tinggi*. Purbalingga: Eureka Media Aksara.

Anantyarta, P., & Sari, R. L. I. (2017). Keterampilan kolaboratif dan metakognitif melalui multimedia berbasis means ends analysis collaborative and metacognitive skills through multimedia means ends analysis based. *Jurnal Biologi dan Pembelajaran Biologi*, *2*(2), 33–43.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. New York, NY: Routledge Academic.

Dwiyanti, E., & Rosana, D. (2020). Pengembangan perangkat pembelajaran berbasis proyek untuk meningkatkan keterampilan proses sains peserta didik. *Jurnal Ilmiah Pendidikan Fisika*, *4*(2), 45-57.

Fauziah, M., & Qomariyah, N. (2020). Kelayakan LKPD materi sistem pernapasan untuk melatihkan keterampilan literasi sains dan berpikir kritis peserta didik kelas X. *BioEdu: Berkala Ilmiah Pendidikan Biologi*, *9*(3), 489–497.

Firdaus, L., Mirawati, B., Pendahuluan, I., & Konstruktivisme, P. (2015). Keterampilan proses sains dalam pembelajaran: suatu tinjauan teoretis 1 & 2. *Center for Open Science*, *1*, 1–4.

Janah, M. C., Widodo, A. T., & Kasmui. (2018). Pengaruh model problem based learning terhadap hasil belajar dan keterampilan proses. *Jurnal Inovasi Pendidikan Kimia*, *12*(1), 2097–2107.

Karamustafaoglu, S. (2011). Improving the science process skills ability of science student teachers using i diagrams. *International Journal of Physics & Chemistry Education*, *3*(1), 26–38.

Kosasih, E. (2021). *Pengembangan bahan ajar*. Jakarta Timur: PT Bumi Aksara

Malawati, R., & Sahyar. (2016). Peningkatan keterampilan proses sains mahasiswa dengan model project based learning berbasis pelatihan dalam pembelaajaran fisika. *Jurnal Pendidikan Fisika*, *5*(1), 58–63.

Maryani, L., Sunyono, & Abddurrahman. (2017). Efektivitas LKPD berbasis project based learning untuk meningkatkan keterampilan proses sains siswa. *Jurnal Pembelajaran Fisika Universitas Lampung*, *5*(3), 1-12.

Mirwanda, C., Halidjah, S., Pranata, R., & Salimi, A. (2024). Pengembangan LKPD berbasis project based learning pada mata pelajaran IPAS materi membuat peta sederhana di kelas IV SDN 24 pontianak tenggara. *Journal On Education*, *6*(4), 19936-19944.

Nurhidayati, B. S., Padlurrahman, & Nuraini. (2023). Pengembangan LKPD Berbasis PJBL Pada Mata Pelajaran Matematika Di Sekolah Dasar. Jurnal Suluh Edukasi, 4(1), 36-42

P21 Framework for 21st Century Learning. (2015). *21st century student outcomes*. USA: Consorcio de Habilidades Indispensables para el siglo XXl.

Purnamasari, J., Wardhani, S., Nawawi, S., & Info, A. (2021). Analisis soal keterampilan proses sains (kps) pada materi biologi di sma kota palembang. *Bioilmi: Jurnal Pendidikan VII*(I), 9–17.

Purwaaktari, E. (2015). Pengaruh model collaborative learning terhadap kemampuan pemecahan masalah matematika dan sikap sosial siswa kelas V SD Jarakan Sewon Bantul. *Jurnal Penelitian Ilmu Pendidikan*, *8*(2), 95–111.

Putri, R. Y., & Prihandono, T. (2022). Analisis Keterampilan Proses Sains Siswa dalam Pembelajaran Rangkaian Seri Paralel Menggunakan Metode Praktikum. *Edumaspul - Jurnal Pendidikan, 6*(1), 497–502.

Redhana, I. W. (2019). Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1), 2239-2253

Roas, N., Kua, M. Y., & Dinatha, N. M. (2024). Pengembangan lembar kerja siswa berbasis project based learning pada pembelajaran ipa kelas viii smps citra bakti. *Edumaspul - Jurnal Pendidikan,(6)*1, 497-502.

Sagala, Y. D. A., Simajuntak, M. P., Bukit, N., & Motlan. (2020). Implementation of project-based learning (PjBL) in collaboration skills and communication skills of students. *Advances in Social Science, Education and Humanities Research*, *384*, 608–612.

Setiawan, R. R., Suwondo, S., & Syafii, W. (2021). Implementation of project based learning student worksheets to improve students' science process skills on environmental pollution in high schools. *Journal of Educational Sciences*, *5*(1), 130-140.

Wahdah, S. R., Hernawati, D,.Diella, D.(2023). Hubungan antara keterampilan interpretasi data dengan keterampilan mengkomunikasikan peserta didik materi sistem ekskresi. *Bioed: Jurnal Pendidikan Biologi, 11* (2). 136 - 141.

Waluyo, E., & Nuraini, N. (2021). Development of instructional design project-based learning model integrated science process skills to improve science literacy. *Jurnal Pendidikan Sains (Jps)*, *9*(1), 104.

Yunita, N., & Nurita, T. (2021). Analisis keterampilan proses sains siswa pada pembelajaran daring. *Pensa E-Jurnal : Pendidikan Sains*, *9*(3), 378–385.

Zekri, G., & Anwar, M. (2020). Pengembangan modul pembelajaran berbasis proyek pada mata pelajaran simulasi dan komunikasi digital SMK. *Pedagogi: Jurnal Ilmu Pendidikan*, *20*(1), 33–42.