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# DEVELOPING LKPD BASED ON DISCOVERY LEARNING TO IMPROVE COLLABORATION AND CRITICAL THINKING SKILLS IN CLASS VIII STUDENTS AT JUNIOR HIGH SCHOOL

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## Abstract

This study aims to describe the feasibility of developing discovery learning-based LKPDs for class VIII students of SMPN 3 Bungku, and to produce LKPDs that can improve students' collaboration and critical thinking skills. This research uses a Research and Development (R&D) approach with the Four D (4D) development model, which involves the Define, Design, Develop, and Disseminate stages, adapted to the characteristics of the subject and development needs in the field. The research design used a nonequivalent pretest-posttest control group design with two classes: experimental and control, to assess the effectiveness of the LKPD development. The results showed that the discovery learning-based LKPD was very valid with an average of 92.31%. The effectiveness was obtained from the analysis of critical thinking skills using pretest and posttest questions, in the experimental class an increase of 30.50% was obtained while in the control class an increase of 28.34% was obtained. Effectiveness was also obtained from collaboration skills using observation sheets in the experimental class, an increase of 14% was obtained while in the control class an increase of only 5% was obtained. Practicality is obtained from the results of the teacher's response which states that the LKPD is practical to use. Then the effect size test obtained a result of 0.80 with a very large effect. So, it is recommended to be able to apply discovery learning-based LKPD more widely in an effort to improve learning collaboration skills and critical thinking at the junior high school level

**Keywords:** Collaboration skills, critical thinking, discovery learning, Four-D model, LKPD.

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## Introduction

Collaboration and critical thinking skills are important in education to form individuals who are ready to face modern-day challenges. Rapid development in today's world requires new generations, especially students, to master various important skills. Education is not only about knowledge, but also about scientific attitudes which include critical, logical, analytical and creative thinking, while remaining adaptable. According to the Partnership of 21st Century Skills, skills for the 21st century involve critical thinking, problem solving, communication, and collaboration (Wangi et al., 2022).

Critical thinking skills are key in dealing with everyday problems in society, according to Wahyuni (2015), who emphasizes the need to develop this ability in learning. This allows individuals to think logically and not accept information easily without careful consideration. On the other hand, collaboration skills, as stated by Kusuma et al (2019), are also important in the learning context because they can improve academic achievement and encourage positive social interactions. Furthermore, these skills enable the exchange of knowledge between individuals, enriching each person's abilities and skills (P21, 2009).

Discovery learning is a learning model that encourages students to actively find information systematically and logically (Lidiana, et al., 2018). As stated by Hosnan (2014) this approach promotes active learning through self-exploration, ensuring the knowledge gained remains in long-term memory. Furthermore, Nurjanah, et al. (2020) emphasized the big role of discovery learning in improving students' conceptual understanding and collaboration skills using Student Worksheets (LKPD) as a tool.

LKPD is learning material that contains a series of tasks for students with step-by-step instructions, aimed at making the learning process easier according to Zakiyah & Yonata (2021). Yusuf's (2016) research shows that applying the discovery learning model with LKPD can improve students' understanding of concepts.

Based on the results of observations carried out at SMPN 3 Bungku, it shows that there is a low learning process and this can also be seen through data from research questionnaires given to students and the results of interviews with teachers. This reflects problems in the delivery of subject matter and the teaching methods used. Then the LKPD used by students is currently inadequate. The LKPD is not based on discovery learning and does not

meet the criteria for critical thinking skills which are very important in 21st century learning. Third, the learning process is still very centered on the role of the teacher. This means that students may receive more knowledge from the teacher rather than being actively involved in the learning process. Teacher-centered education may be less effective in developing students' critical thinking and collaboration skills. This is in accordance with the opinion of several previous studies by Nurjannah et al. (2020) reported a significant increase in collaboration skills and concept mastery through the use of discovery learning-based LKPD. Rajagukguk et al. (2020) stated that this LKPD is suitable for use in science learning, improving student learning outcomes. Syafii (2022) noted an increase in students' collaboration skills in buffer solution material using the discovery learning learning model. Yanto & Arsyad (2023) emphasize the importance of active learning models such as discovery learning to improve students' collaboration skills.

Based on the description above, discovery learning-based LKPD is very important because it can improve 21st century skills, especially collaboration and critical thinking, which are essential for the younger generation in facing the challenges of the modern era. Observations at SMPN 3 Bungku show the low effectiveness of the learning process and the inadequacy of the existing LKPD, so this research aims to overcome these problems with a more active and participatory approach. Therefore, an in-depth study is needed regarding Developing LKPD based on discovery learning to improve collaboration and critical thinking skills in class VIII at SMPN 3 Bungku.

## Methods

This research uses the method *Research and Development* (R&D) with the aim of creating and testing the effectiveness of certain products (Sugiyono, 2019). The development model used is 4D (Four D) by Sivasailam Thiagarajan et al. (1974), which includes four stages: define, design, develop, and disseminate. This model was chosen because it is programmatic, simple, easy to understand and systematic, and is suitable for developing teaching materials. At the define stage, identification of learning objectives, analysis of students, and determination of topics or concepts for discovery learning are carried out. The design stage involves planning experimental activities for students, determining the resources needed, and planning exploration steps. At the develop stage, LKPD is created according to the discovery learning method and ensures that the LKPD contains clear instructions. The dissemination stage includes trialling the LKPD, revisions based on the trial results, and distributing the LKPD to teachers or other institutions.

This research uses a nonequivalent experimental design pre-test post-test control group design involving two classes: experimental and control, where critical thinking skills are measured through an initial test (pretest) and a final test (posttest). The research was conducted at SMP Negeri 3 Bungku from December 2023 until completion, with research subjects of 30 class VIII students, consisting of 16 boys and 14 girls, with an average age of 13.5 years. There were 4 meetings with material about motion and force. The instruments used include 4-item essay questions and a questionnaire with 10 statements using a 1-5 Likert scale.

The main variable is the development of LKPD using a discovery learning approach, while supporting variables include assessment of students' collaboration and critical thinking skills. The data used consists of quantitative and qualitative data. Quantitative data includes LKPD validation tests, questionnaire validation tests, and effectiveness tests, while qualitative data comes from the results of validation sheet assessments and student responses in questionnaires. Data collection techniques include observation, questionnaires and tests. The instruments used in this research include Learning Implementation Plans (RPP) and Student Worksheets (LKPD) for learning tools, as well as validation sheets, teacher and student response questionnaires, and product validation for data collection.

Data analysis includes validity analysis which is calculated based on validation scores and interpreted according to validity level categories (Herawati et al., 2016), practicality analysis which is calculated from questionnaire answer scores and interpreted according to practicality level categories (Herawati et al., 2016), as well as effectiveness analysis which includes critical thinking skills measured through pretest and posttest using Cohen's (2007) Effect Size formula;

$$S_{of} = \sqrt{\frac{Spre^2 + Spost^2}{2}}$$

*Effect Size* d can be calculated as:

$$d = \frac{\bar{d}}{S_{of}} \qquad (1)$$

Information:

$S_{of}$ = Standard deviation of test scores

$\bar{d}$ = Average test score ($M_{Posttest}$ - $M_{Pretest}$)

$S_{pre}$ = Pretest standard deviation

$S_{post}$ = Posttest standard deviation

Spears et al, (2013) states that standard deviation is best for paired designs and also as an option *standardizer* the best is $S_{of}$.

Collaboration skills are measured through a questionnaire, calculated using a percentage formula (Sari, et al., 2016) and interpreted according to the assessment score category.

$$V = \frac{A}{B} \; X \; 100\% \qquad (2)$$

where V = Percentage Value; A = Total Score achieved; and B = Maximum Total Score

## Results and Discussion

This research combines a quasi-experimental method with a pretest-posttest control group design and a 4D (Four-D model) development model to develop Student Worksheets (LKPD) based on Discovery Learning. The focus of this research is to see the effect of using LKPD on the collaboration and critical thinking skills of class VIII students at SMPN 3 Bungku. The following is a description of the steps and results of the research:

**1. Define**

At the define stage in developing Student Worksheets (LKPD) based on Discovery Learning, this research focuses on identifying student needs, their characteristics, and the competencies that must be achieved. Based on the results of the analysis, it was found that class VIII students at SMPN 3 Bungku need more interactive and interesting learning media, which can stimulate their active involvement in the learning process. Effective media must be able to facilitate collaboration between students and encourage their creativity in solving problems.

**2. Design**

At the design stage, Student Worksheets (LKPD) based on Discovery Learning are designed to encourage students to collaborate and think critically with a focus on force and motion. The structure of the LKPD is arranged systematically to facilitate interactive and in-depth learning, according to the special needs of force and movement material.

The concept introduction section in the LKPD aims to provide students with a basic understanding of the concepts of force and motion, including the basic principles of physics and examples of their application in everyday life. Exploratory tasks in LKPD are designed to challenge students to discover concepts through hands-on activities and experiments, involving observation, experimentation, and data analysis.

The group discussion section allows students to share understanding and knowledge, encouraging collaboration and communication. This discussion includes joint problem solving, analysis of experimental results, and application of physics concepts in real situations. The reflection section in the LKPD provides an opportunity for students to reflect on learning and relate it to personal experiences, helping them to internalize physics concepts and understand their relevance in everyday life.

All activities in the LKPD are designed to encourage students' active involvement in exploration and discussion, as well as improve their critical thinking skills. Challenging guiding questions are also included to stimulate innovative thinking and problem solving.

**3. Development**

At the development stage, the Student Worksheet (LKPD) which has been designed through the design process is then developed into a physical form that is ready to be used in learning. This process includes several important steps to ensure the effectiveness and ease of use of the LKPD by students. At this stage, researchers identify the core competencies (KI) and basic competencies (KD) needed in developing LKPD. Based on this identification, the researchers determined several indicators related to motion and force materials.

Making LKPD uses visual and contextual tools to clarify the concepts being taught and facilitate students' understanding. Visual aids such as diagrams, pictures, and graphs help explain complex information in a simpler and more interesting way. Contextual tools, such as real examples that are relevant to students' daily lives, are used to help students connect theory with real practice, so that the material studied becomes more meaningful.

After the development of the LKPD is complete, the next step is validation by educational experts and practitioners. This validation aims to ensure that the LKPD meets the desired educational standards and is effective in achieving learning objectives. Experts evaluate LKPD from various aspects, including suitability of material, clarity of instructions, relevance of learning activities, and ability of LKPD to encourage collaboration and critical thinking.

**Table 1.** Validation of LKPD by material experts and media experts

| Evaluation Aspects | Acquired Score | |
|---|---|---|
| | VALIDATOR 1 | VALIDATOR 2 |
| Concept Truth | 4 | 4 |
| | 4 | 4 |
| Depth of Material | 4 | 4 |
| Based LKPD *Discovery learning* | 4 | 4 |
| | 3 | 4 |
| | 4 | 4 |
| | 3 | 3 |
| Compatibility with based learning *discovery learning* | 4 | 4 |
| | 4 | 4 |
| | 3 | 3 |
| | 3 | 4 |
| | 3 | 4 |
| Accessibility | 4 | 3 |
| Total score | **47** | **49** |
| Rate-rate | **3.62** | **3.77** |
| Percentage (%) | **90.38** | **94.23** |
| Interpretation | **Very Valid** | **Very Valid** |

Based on the validation results, the Discovery Learning-based LKPD was assessed as very valid by Validator 1 with a score of 90.38% (average 3.62) and Validator 2 with a score of 94.23% (average 3.77), indicating that this LKPD suitable for use in class VIII with only minor revision required. The two validators assessed this LKPD as very valid based on criteria such as correctness of concepts, depth of material, and suitability for discovery learning-based learning. Minor revision recommendations include improving instructions to make them clearer, adding supporting material in the form of pictures or graphs, and a section for more detailed feedback from students. With this minor revision, it is hoped that the LKPD can effectively improve students' collaboration and critical thinking skills, supporting them in achieving optimal learning outcomes in class VIII SMPN 3 Bungku.

Next, the following are the validation results from the validator regarding the instruments and learning implementation plans used in this assessment as in the Table 2.

**Table 2.** Results of validation of RPP and collaboration and critical thinking instruments

| Analysis | Validator I | | | Validator II | | |
|---|---|---|---|---|---|---|
| | Score | Rata-Rata | % | Score | Rate-rate | % |
| lesson plan | 73 | 4.29 | 85.88 | 75 | 4.41 | 88.24 |
| Collaboration Instrument | 88 | 4.40 | 88.00 | 88 | 4.40 | 88.00 |
| Critical Thinking Instrument | 89 | 4.45 | 89.00 | 90 | 4.50 | 90.00 |
| Interpretation | **Very Valid** | | | **Very Valid** | | |

The validation results show that the tools used, including the RPP, critical thinking skills and collaboration skills instruments, are very valid. High scores from both validators indicate that all instruments and lesson plans have met the validity criteria required for use in research. This evaluation includes aspects of clarity, completeness and suitability of the material to the expected learning objectives.

Based on input from the validation process, the LKPD is then revised to correct any deficiencies found. These revisions may include adjustments to the material, simplifying instructions, adding visual aids, or changing learning activities to make them more effective. This revision process is carried out iteratively, that is, the LKPD is revised and validated again until it meets the desired standards. Several suggestions from validators regarding the LKPD that have been made. LKPD must display indicators of collaboration and critical thinking. The questions must encourage students to work together and think deeply, not only understanding basic concepts (C1, C2, C3), but also including analysis, evaluation and creation (C4, C5, C6). RPPs must reflect collaborative student activities and critical thinking when working on LKPD, in accordance with Discovery Learning syntax. Each stage, from stimulation to generalization, is designed to encourage collaboration and critical analysis. Include barcodes that make it easier to access resources by using bit.ly for simple links. The core of the LKPD and RPP must demonstrate collaboration and Discovery Learning, ensuring students are actively involved in collaboration and critical thinking. The following are the results of the revision of the Discovery Learning-based LKPD:

Next are teacher assessments, individual tests and small group tests on the LKPD being developed. The aim is to find out the practicality of LKPD in learning. The LKPD was assessed by three science subject teachers. The results of the teacher assessment analysis can be seen in the Table 3.

**Table 3.** Results of teacher assessment analysis of LKPD

| Description | Appraiser 1 | Appraiser 2 | Appraiser 3 |
|---|---|---|---|
| *Total score* | 38 | 38 | 34 |
| *Rate-rate* | 3.80 | 3.80 | 3.40 |
| *Percentage (%)* | 95 | 95 | 85 |
| *Interpretation* | ***practical*** | ***practical*** | ***practical*** |

Based on the Table 3, it is found that assessor 1 obtained an average score of 3.80, a percentage of 95%, assessor 2 also obtained an average score of 3.80, a percentage of 95% and assessor 3 obtained an average score of 3.40, percentage 85%. Complete analysis in attachment 20 page 151, with practical categories used in learning.

Next, individual tests were carried out by 6 students with details of 2 people with high ability, 2 people with medium ability and 2 people with low ability. The results of individual test analysis can be seen in the following table:

**Table 4.** Results of individual test analysis/individual test

| Description | Results |
|---|---|
| Total score | 200 |
| Rate-rate | 3.70 |
| Percentage (%) | 92.59 |
| Interpretation | **Practical** |

Based on Table 4, it can be seen that the individual test results obtained an average score of 3.70, a percentage of 92.59%. with practical categories used in learning

Then the small group test was carried out by 15 students. The results of the analysis can be seen in the Table 5.

**Table 5.** Results of small group test analysis

| Description | Results |
|---|---|
| Total score | 492 |
| Rate-rate | 3,64 |
| Percentage (%) | 91,11 |
| Interpretation | **Practical** |

Based on Table 5, it can be seen that the results of the small group test obtained an average score of 3.64, a percentage of 91.11%. Based on these results, it can be concluded that LKPD is practically used in learning.

Next, distribute questionnaires to find out teachers' responses to the Based LKPD *Discovery Learning* which has been developed by 3 people with the following results:

**Table 6.** Results of teacher responses to LKPD *Discovery Based Learning*

| No | Rated aspect | Average Rating | | | Rate-rate |
|---|---|---|---|---|---|
| | | I | II | III | |
| 1 | Knowledge construction | 3.00 | 3.75 | 4.00 | 3.58 |
| 2 | Design | 4.00 | 3.50 | 4.00 | 3.83 |
| 3 | Language | 4.00 | 4.00 | 4.00 | 4.00 |
| 4 | Activity based *discovery learning* | 4.00 | 4.00 | 3.60 | 3.87 |
| **Rate-rate** | | | | | **3.82** |
| **Percentage** | | | | | **95,50** |
| **Category** | | | | | **Very Practical** |

From the Table 6 it can be seen that from a maximum score of 4, an average value of 3.82 was obtained in the very practical category. This shows that LKPD is based *discovery learning* This is very practical to use in the learning process.

Furthermore, the LKPD that had been developed was then tested in class VIII at SMPN 3 Bungku with 2 classes, namely the experimental class and the control class to test its effectiveness in improving students' collaboration and critical thinking skills. At the implementation stage, research was carried out in the experimental class and control class with the following procedure sequence: (1) conducting a pretest in both classes, then students were divided into small groups to use LKPD during learning activities. The aim of group division is to encourage cooperation and interaction between students, so that they can share ideas and help each other in completing the tasks on the LKPD. Each group is expected to work collaboratively, with each group member contributing according to their abilities and knowledge. (2) carrying out learning activities on motion and force as well as Newton's laws, with the application of LKPD-based materials *discovery learning* in the experimental class and conventional LKPD in the control class; (3) observing students' collaboration skills during the learning process using observation sheets; (4) after learning was carried out over three meetings, the researcher conducted *posttest* in both classes; (5) distributing student and teacher response questionnaires to student-based LKPD *discovery learning*; (6) analyzing data; (7) discussing the results and making conclusions.

The role of teachers in this implementation is very crucial. The teacher functions as a facilitator who guides the learning process and ensures that every student is actively involved. As a facilitator, the teacher not only provides instructions but also supports students by providing guidance, motivating, and asking challenging guiding questions. Teachers also manage group dynamics, ensuring that all students participate and work well together. Thus, the teacher's role is to create a conducive learning environment, where students feel comfortable to explore and innovate.

At the next stage, the LKPD that had been tested was carried out to measure the effectiveness of the LKPD-based LKPD *Discovery Learning* in improving the collaboration and critical thinking skills of class VIII students at SMPN 3 Bungku. This evaluation process involves several data collection methods, both quantitative and qualitative, to provide a comprehensive picture of the impact of using LKPD.

One of the main methods used is a learning outcomes test, which is carried out before and after the implementation of the LKPD. This test is designed to measure students' increased abilities in terms of collaboration and critical thinking. Initial test (*pre-test*) is given before students use the LKPD to obtain basic data regarding their skills. After several sessions of using the LKPD, the final test (*post-test*) is given to assess changes and improvements that occur. The test results showed a significant increase in scores, indicating that students experienced progress in the expected skills. The following is a table of average values *pretest* and *posttest* in the control class and experimental class:

**Table 7.** Average value *pretest* and *posttest*

| Research Class | Average value | |
|---|---|---|
| | Pretest | Posttest |
| Experiment | 48.33 | 78.83 |
| Control | 38.33 | 66.67 |

Based on the table above, it shows the average value *pretest* and *posttest* in both classes. The experimental class experienced a significant increase in average scores *posttest* compared to value *pretest*, shows the effectiveness of the implemented intervention. On the other hand, the control class also showed an increase in scores *posttest*, but the increase is not as high as the experimental class. Complete analysis in attachment 22 page 153 and attachment 23 page 154. A comparison of the average values indicates that the approach used in the experimental class is more

effective in increasing concept mastery compared to the method used in the control class. These results are again analyzed with values *effect size.* Based on average value *effect size* is 0.80 in the experimental class and control class, indicating that the impact is very large. This means that the intervention or treatment given to the experimental class has a very significant effect compared to the control class. According to interpretation *effect size*, this value shows that the intervention has an influence on student learning outcomes which shows that students' critical thinking skills are included in the very large category. In other words, learning uses LKPD-based learning *Discovery Learning* greatly influences students' critical thinking skills. Then to see the effectiveness of the LKPD-based *discovery learning* the author continues with a t-test using statistical software, where:

1. If the Sig. > 0.05 then it can be concluded that the data variance *effect size* for the experimental class and control class are the same or homogeneous.
2. If the Sig. < 0.05, it can be concluded that there is a significant (real) difference in effectiveness between the use of LKPD-based *discovery learning* in the experimental class and control class, as in the following table:

Based on the results of the t-test, the experimental group, which used discovery learning-based LKPD, obtained an average score of 56.83 with a standard deviation of 15.18. Meanwhile, the control group, which did not use discovery learning-based LKPD, had an average score of 44.85 with a standard deviation of 14.47. The test results show that the difference in scores between the two groups is significant, with a t value of 5.262 and a two-way significance (Sig. 2-tailed) of 0.000, which shows that the use of discovery learning-based LKPD has a positive effect on improving student learning outcomes in the experimental class. Furthermore, the results of the analysis based on indicators of critical thinking skills can be seen in the Table 8.

As can be seen from Table 8 that the highest percentage of the three indicators in critical thinking questions was the indicator of providing a simple explanation at 84.67%, followed by the indicator for building basic skills at 76% and the indicator for concluding at 68.67%.

Furthermore, in assessing student collaboration skills, the results obtained are as shown in the Table 9. Based on the results of research using Student Worksheets (LKPD) based *Discovery Learning*, there was a significant increase in students' collaboration skills in the experimental class compared to the control class.

**Table 8.** Results of analysis of critical thinking skills indicators

| CBC indicator | Average Score | | Percentage | |
|---|---|---|---|---|
| | Pretest | Posttest | Pretest | Posttest |
| Provide a Simple Explanation (*Elementary Clarification*) | 14.75 | 21.17 | 59 | 84.67 |
| Building Basic Skills (*Basic Support*) | 9.67 | 19 | 36.67 | 76 |
| Summing up (*Inference*) | 7.83 | 17.17 | 31.33 | 68.67 |

**Table 9.** Collaboration skills assessment analysis results

| No | Analysis | Results | | |
|---|---|---|---|---|
| | | Meeting I | Meeting II | Meeting III |
| 1. | Experiment Class | 80 % | 90 % | 94 % |
| 2. | Control Class | 73 % | 75% | 78% |

At the first meeting, the experimental class achieved 80% in the collaboration skills assessment, while the control class only achieved 73%. At the second meeting, the experimental class increased to 90%, while the control class only increased slightly to 75%. At the third meeting, the experimental class reached 94%, much higher than the control class which only reached 78%.

So from these results, it can be concluded that the use of LKPD is based on *discovery learning* effective in improving students' collaboration skills. The experimental class that used this method showed higher improvement in each meeting compared to the control class that did not use this method. The difference in results between the experimental class and the control class which is getting bigger from the first to the third meeting indicates that the method is used *discovery learning* through LKPD not only improve collaboration skills significantly but also consistently in subsequent meetings. Thus, this research supports the use of LKPD-based *Discovery Learning* as an effective method in learning to improve students' collaboration skills.

The scores for indicators of collaboration skills in the experimental class and control class can be seen in the Table 10.

**Table 10.** Description of student collaboration skills score

| Indicator | Experimental Class | | | Control Class | | |
|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P1 | P2 | P3 |
| Collaborative attitude and character | 81% | 90% | 94% | 72% | 74% | 80% |
| Collaborative active behavior | 79% | 90% | 94% | 73% | 73% | 76% |
| Skills | 87% | 89% | 96% | 74% | 77% | 78% |

Based on the Table 10, it can be seen that in the experimental class, the indicator of collaborative attitude and character at the first meeting obtained a percentage of 81%, at the second meeting the percentage was 90% and at the third meeting the percentage was higher, namely 94%. The active collaborative behavior indicator obtained a percentage of 79% for the first meeting, 90% for the second meeting and 96% for the third meeting and the skills indicator obtained a percentage of 87% for the first meeting, 89% for the second meeting and 96% for the third meeting. In the control class, the indicator of collaborative attitude and character at the first meeting obtained a percentage of 72%, at the second meeting the percentage was 74% and at the third meeting the percentage was 80%. The active collaborative behavior indicator obtained a percentage of 73% for the first meeting, 73% for the second meeting and 76% for the third meeting and the skills indicator obtained a percentage of 74% for the first meeting, 77% for the second meeting and 78% for the third meeting. The results of the analysis of collaboration skills in the experimental class and control class show that the collaboration skills in the experimental class are higher than the control class. This shows that the use of LKPD is based *discovery learning* on effective movement and force material used to improve students' collaboration skills.

**Analysis of collaboration skills and critical thinking skills through (LKPD) based *discovery learning***

Based on research results, the use of Discovery Learning-based Student Worksheets (LKPD) has proven to be effective in improving students' collaboration skills and critical thinking skills.

**a. Collaboration skills**

Collaboration skills are assessed from three indicators, namely collaborative attitudes and character, active collaborative behavior and skills. Research shows that the experimental class, which used Discovery Learning-based LKPD, experienced a significant increase in students' collaboration skills compared to the control class.

The results of the analysis in the experimental class showed that the three indicators of students' collaboration skills showed an increase from the first meeting to the third meeting in the very good category. The control class also experienced an increase in collaboration skills to the good category. Comparative analysis of the average scores of students' collaboration skills between the experimental class and the control class highlights the differences in the effectiveness of the LKPD between the two learning models. With the average score increasing significantly from meeting to meeting, the experimental class showed a consistent upward trend, starting from 80% at the first meeting, to reaching 94% at the third meeting. On the other hand, the control class only showed limited improvement, from 73% at the first meeting, to 78% at the third meeting. This difference confirms that Discovery Learning-based LKPD consistently provides a better impact on students' collaboration skills.

Furthermore, these differences also indicate that the effects of learning interventions are not just one-time, but also ongoing. In this context, the experimental class not only showed greater improvement in each meeting, but also significantly improved student performance from meeting to meeting. This shows that the Discovery Learning-based learning method is able to stimulate the development of students' collaboration skills continuously over time.

Then the results of this research provide an indication that the use of Discovery Learning-based LKPD can be a very effective strategy in facilitating collaborative learning in the classroom. By giving students the opportunity to work together to explore course material, share knowledge, and solve problems together, this approach not only improves mastery of the material, but also enriches social and collaborative skills that are essential for success in the real world.

This significant difference shows that Discovery Learning-based LKPD has a greater influence on collaboration skills than the learning method used in the control class.

**b. Critical thinking skills**

Based on the results obtained, it shows that the treatment applied in the experimental class, using discovery learning-based LKPD, significantly improves students' critical thinking skills. This is evident from the substantial increase between the pretest and posttest scores in the experimental group, where the posttest score reached 78.83 from the pretest score of 48.33, an increase of 30.50. This increase shows that a learning approach that encourages independent exploration, analysis and evaluation of concepts has been effective in building students' ability to think critically. Although the control group also experienced an increase in the posttest score from the pretest, namely 28.33. The score obtained was not as big as what happened in the experimental group. This shows that the conventional learning methods applied to the control group were not fully able to optimize the development of students' critical thinking skills as happened in the experimental group.

Furthermore, the analysis of the effect size values confirmed that the influence of the intervention on students' critical thinking skills was very significant. With an effect size value of 0.80, this influence can be interpreted as a very large effect. This indicates that the LKPD-based learning method oriented towards Discovery Learning not only increases mastery of concepts, but also specifically enriches students' abilities in analyzing information,

evaluating arguments, and developing in-depth critical thinking. Thus, the application of a Discovery Learning-based learning model using LKPD has a very big influence in improving students' critical thinking skills.

Based on the results of the t test which shows a significant value (2-tailed) of 0.000, which is smaller than 0.05, it can be concluded that there is a significant difference between the learning outcomes of the control class and the experimental class. The learning outcomes of the experimental class have a greater average than those of the control class. These findings indicate that discovery learning-based LKPD applied in experimental classes is more effective in improving student learning outcomes.

Furthermore, these results have important implications regarding students' critical thinking skills. The increase in average learning outcomes in the experimental class shows that the discovery learning-based LKPD used not only increases students' understanding of the material, but also strengthens their critical thinking skills. Critical thinking skills involve the ability to analyze, evaluate, and make decisions based on available information. Learning models in experimental classes, which may include discussion, case analysis, and problem solving, appear to be more effective in developing these abilities compared to methods used in control classes. In line with the opinion of Erawati et al. (2022) LKPD can increase understanding in studying lesson material, as well as develop students' creativity in optimizing problem solving abilities.

Based on this research, it was found that the indicator of critical thinking skills obtained the highest average score of 21.17 and a percentage of 84.67% for the indicator providing a simple explanation. This shows that students already have the basic ability to answer questions based on arguments. This is in line with the opinion of Meriyati (2023) that junior high school students already have basic ability characteristics such as cognitive or intellectual abilities. However, the indicator for making conclusions obtained the lowest average score, namely 17.17% and a percentage of 68.67%. This may be because students are not careful in reading and understanding the questions. Karim and Normaya (2015) state that before making a decision or taking an action, collect as much information as possible about that thing. Therefore, students still need more practice or guidance in identifying HOTS questions so that students get used to solving HOTS questions.

Based on the results of the analysis above, it can be concluded that learning using Discovery Learning-based LKPD is very effective in improving students' collaboration skills and critical thinking skills. The experimental class showed significant and consistent improvements in both aspects compared to the control class. Therefore, the use of discovery learning-based LKPD is highly recommended for application in learning to achieve more optimal results in students' collaboration and critical thinking skills. The use of Discovery Learning-based LKPD is an effective and efficient method in improving the quality of learning in the classroom (Anggarwati & Ningsih, 2024).

In developing LKPD, this research utilizes the development of 4D (Four-Dimensional Model) Define, Design, Development and Disseminate. At the define stage, it was found that students needed interactive and contextual learning media to stimulate their active involvement, collaboration and critical thinking. The identified basic competencies emphasize collaborative and critical thinking skills, which are important for preparing students to face future challenges. Learning barriers found in conventional methods indicate the need for innovation in teaching approaches.

Designing discovery learning-based LKPD for movement and force material has the main aim of encouraging students to collaborate and think critically. The structure of the LKPD is designed systematically, including concept introduction, exploratory tasks, group discussions and reflection. This material is presented through hands-on activities, experiments, and discussions that stimulate collaboration and communication between students. Challenging guiding questions are added to spark innovative thinking. Thus, this worksheet facilitates interactive and in-depth learning, while improving students' collaborative and critical thinking skills in the context of force and motion

At the development stage, the Student Worksheet (LKPD) which has been designed through the design process is developed into a physical form that is ready to be used in learning. This development process involves several important steps to ensure that the worksheet is effective and easy for students to use. Making LKPD is done using visual and contextual tools to clarify the concepts being taught and facilitate students' understanding. Visual aids such as diagrams, pictures, and graphs are used to explain complex information in a simpler and more interesting way. Contextual tools, such as real examples that are relevant to students' daily lives, are also included to help students connect theory with real practice, so that the material studied becomes more meaningful (Putri, et al, 2023).

After the LKPD is developed, the next step is validation by education experts and practitioners. This validation aims to ensure that the LKPD meets the desired educational standards and is effective in achieving learning objectives. Experts evaluate LKPD from various aspects, including suitability of material, clarity of instructions, relevance of learning activities, and ability of LKPD to

encourage collaboration and critical thinking. Based on the results of the validation carried out, the value obtained from Validator 1 was 90.38 and from Validator 2 it was 94.23. These results indicate that the discovery learning-based LKPD is very valid with little revision required and is suitable for use in class VIII. The scores given by the two validators indicate that this LKPD has met good assessment criteria, including suitability of material, clarity of instructions, completeness of content, accuracy of the Discovery Learning method, as well as its ability to encourage students' collaboration and critical thinking skills. Suggested minor revisions include improving instructions to make them clearer, increasing supporting materials with additional images, with minor revisions suggested, this LKPD is expected to be able to effectively improve students' collaboration and critical thinking skills, supporting them in achieving optimal learning outcomes in class VIII SMPN 3 Benches.

Furthermore, the LKPD that had been developed was tested in class VIII of SMPN 3 Bungku with two classes, namely the experimental class and the control class to test its effectiveness in improving students' collaboration and critical thinking skills. At this stage, research was carried out in the experimental class and control class with a systematic procedure sequence. The teacher acts as a facilitator who guides the learning process and ensures that every student is actively involved. This process involves collaborative activities, the use of critical thinking skills and collaboration skills instruments, as well as evaluation through pre-tests and post-tests (Winasih & Malawi, 2023).

The evaluation results show that the use of discovery learning-based LKPD has a significant influence on improving students' skills. The average pre-test and post-test scores in the experimental class showed a significant increase compared to the control class, with an effect size value of 0.80 which was in the very large category. This confirms that learning using Discovery Learning-based LKPD is very effective in improving student learning outcomes, especially in collaboration and critical thinking skills. In conclusion, Discovery Learning-based LKPD is a valid, practical and effective learning tool, which deserves to be widely implemented in the learning process in class VIII SMPN 3 Bungku. In research by Nurjanah et al. (2020) it was revealed that learning using discovery learning-based LKPD was effective in improving students' collaboration skills. Implementation of learning using the discovery learning model equipped with LKPD shows an increase in student learning outcomes and collaboration skills each cycle. In the first cycle, the percentage of completeness of student learning outcomes was 29.4%, and in the second cycle it increased to 41.1% (Nufus et al. 2024). According to Sinaga (2021), the use of the Discovery learning method can increase student learning activity. Furthermore, according to Subakti et al. (2021) the development of E-LKPD using the discovery learning model is able to improve critical thinking skills.

## Conclusions

Based on this research, Discovery Learning-based LKPD is proven to be valid, effective and practical, meeting the desired educational standards. Its effectiveness was demonstrated by significant improvements in students' collaboration and critical thinking skills, while its practicality was proven through classroom trials, with students and teachers stating the LKPD was easy to use and very helpful in learning. The development of this LKPD through the 4D model (define, design, develop, disseminate) was successful. At the define stage, learning problems are identified to improve collaboration and critical thinking skills. The design stage involves preparing a detailed learning plan, while the develop stage includes the development and validation of LKPD by experts. The disseminate stage involved distributing LKPD and testing in experimental and control classes, which showed a significant increase in students' skills in the experimental class. The validation results show that the LKPD is very valid and effective, so it is worthy of being widely implemented in learning in class VIII SMPN 3 Bungku.

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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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