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Analysis of Students' Thinking Ability in Discovery Learning Based Worksheets to Improve Mathematical Problem-Solving Ability

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Abstract

Problem-solving ability is essential in the process of learning mathematics. Looking at students' mathematical problem-solving abilities, which can be seen from the learning outcomes, are still less than the expected average. One of the efforts that can be made to improve students' problem-solving skills is to develop Discovery Learning-based worksheets. This study analysed students' thinking skills to improve their mathematical problem-solving abilities. This study uses a qualitative approach with a case study method that emphasizes real cases. This research was conducted on SMP Negeri 6 Metro class VII students on Quadrilaterals. The research used a purposive sampling technique to study as many as 26 students as subjects. The data analysis process was carried out by describing the results of the analysis of answers in writing and showed the ability to write systematic problem-solving procedures. The study results in show that the developed LKPD is very valid; it can be seen that: (1) the achieving results the high category in the application of the Discovery Learning model, (2) the score of each aspect of problem-solving in mathematics has increased, (3) the final test average score has increased, and (4) the score of each problem-solving indicator in mathematics has increased. This can be seen based on the test, and the results show a significant difference between the average increase in learning outcomes in the experimental class using discovery learning-based worksheets and the control class that does not use discovery learning-based worksheets. So it can be concluded that the developed LKPD based on discovery learning is valid, practical, and effective for improving students' mathematical problem-solving abilities.

INTRODUCTION

Mathematics is a subject studied by elementary, middle, and college students. This is intended to equip students to think logically, analytically, systematically, critically and creatively and to be able to work together [1]. One of the objectives of learning mathematics is to solve problems, including the ability to understand problems, design mathematical models, complete models, and interpret the models obtained [2]. One of the competencies that students in mathematics curriculum must possess is the ability to solve problems [3]–[6]. Essential aspects of mathematics learning can be well developed through problem-solving activities. Some experts find several ways to solve math problems, including Polya. According to Polya, the steps in

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solving problems include the first steps in solving mathematical problems, namely analyzing and understanding a problem (analyzing and understanding the problem). In this step, students must be able to analyze and understand existing problems by determining and looking for what is known and what is asked of the problem. The second step is designing and planning a solution (designing and planning a solution). In this step, students must be able to design and plan existing solutions based on what is known and asked about the problem according to the first step. The third step is exploring solutions to complex problems (finding solutions to problems). In this step, students must determine a solution to be able to solve existing problems by the plans that have been made in the second step. The fourth step is verifying a solution (checking the solution). In this step, students must be able to recheck the results obtained, whether the answers are correct and what was asked in the problem [3].

Problem-solving is a process a person takes to solve problems [7]. Problem-solving abilities will be more effective and increase if the discovery learning model is assisted [8]–[10]. This is in line with several previous studies, namely, according to Henry and Kenedy [11], [12], learning devices that contain discovery learning-based worksheets can improve students' problem-solving abilities. Furthermore, Henry and Kenedy [13] significantly increase problem-solving abilities with the discovery learning model and positively impact students' skills in solving mathematical problems. The discovery learning model can encourage students. Henry and Kenedy [14] show increased problem-solving abilities and the completeness of problem-solving skills taught by the discovery learning model. This discovery learning model is a learning that significantly improves students' problem-solving abilities and has a beneficial impact on their mathematical problem-solving abilities. Learners are encouraged to solve math problems by finding their answers using discovery learning techniques.

In addition, knowledge obtained through discovery activities will last a long time and be more accessible for students to remember. However, from this research, no one has analyzed the increase in student problem-solving in LKPD by applying the discovery learning model to improve problem-solving centred on quadrilateral material. Based on field data, it was found that students' problem-solving abilities tended to be low. The low problem-solving ability of students was also seen in the results of the daily tests for class VII students of SMPN 6 metro. This is because students are not involved directly in discovering concepts, so students tend to memorize formulas without understanding the concept. As a result, students tend to be unable to solve problems. Therefore, teachers should use learning models that can develop students' mindsets of students so that student learning outcomes can be better. The teaching and learning process is the essence of improving the quality of education. The teacher must direct students towards the expected learning goals so that these goals can be achieved optimally. The availability of adequate learning tools such as LKPD will assist teachers in carrying out the learning process to achieve the expected learning goals and objectives.

Based on the problems described, this study aims to analyse students' thinking skills in discovery learning-based worksheets to improve problem-solving skills.

METHOD

Research and development methods (R&D) to produce a product. According to [15] explaining, R&D is a method used to produce specific products and test the effectiveness of these products. The product developed in this study is a discovery learning model-based

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worksheet to improve problem-solving skills for students with quadrilateral material at the junior high school level. This research was conducted on class VII students of SMP Negeri 6 Metro. This research and development use the Borg and Gall development model. There are ten stages of the Borg and Gall development model [16].

The Borg and Gall development stages are simplified into six steps, up to the main field testing stage. This is due to the limitations of time, effort, and costs owned by researchers and learning conditions. The research and information collecting phase (research and information collecting) it is carried out to find out the problems faced by educators by conducting interviews and to find out the results of learning mathematics, namely by giving four math questions in the form of descriptions to measure problem-solving abilities to 26 class VII students. The phase of developing the initial product form (develop a preliminary form of product) is carried out to determine the development goals, namely the development of worksheets by determining the learning objectives of the quadrilateral material using the discovery learning model, then the steps using the discovery learning model after completing the preparation of the LKPD along with the accompanying learning tools (syllabus, lesson plans, and problem-solving ability test questions), which are then assessed by material, media, and language expert examiners to find out the feasibility of the content, language, and appearance of the LKPD that has been made. The material expert's assessment consisted of 20 assessment indicators, media experts (views) consisted of 17, and language experts consisted of 10 assessment indicators. LKPD is validated with material experts to find out the material's scope, the material's accuracy, and the material's ability to improve students' problem-solving abilities.

Validation with media experts to find out the presentation techniques in LKPD, presentation in learning, and completeness of presentation, as well as validation with linguists to find out the use of sound and correct language to suit students' level of development. Validation with experts aims to get comments, suggestions or input and determine whether the LKPD and learning tools have met the required criteria. The initial field testing phase (preliminary field testing) was carried out to see the difficulties that might occur in using LKPD during the learning process by giving response questionnaires to mathematics educators on LKPD and learning tools that have been developed. Proceed with giving a pre-test to determine students' initial problem-solving abilities. Then students are asked to assess the LKPD using a student response questionnaire based on the discovery learning model. The product revision phase of the initial field test results (primary product revision) was carried out for improvement based on the results of the questionnaire analysis of the responses of educators and students to the discovery learning model-based LKPD as a whole according to the suggestions obtained at the initial field trial stage for product improvement. The last phase is the primary field testing conducted to determine the effectiveness of LKPD on students' problem-solving abilities. Before the product trial, the treatment was given to students in the experimental and control classes. The pre-test aims to determine students' initial abilities regarding the study material. The next step is product testing in worksheets based on the discovery learning model with problem-solving abilities in the experimental class, while the conventional model is used in the control class. After the entire lesson has been given to students in both classes, a post-test is then given to determine students' problem-solving abilities.

Field test results data that has been obtained data analysis will be carried out so that the practicality and effectiveness of the product will be known. The validity assessment instrument

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consists of LKPD validation sheets, pre and post-test validation sheets, and problem-solving skills. The practicality assessment instrument consisted of a teacher's response questionnaire and a student's response questionnaire. The effectiveness assessment instrument consists of the problem-solving ability test based on data analysis of the pre-test and post-test results carried out by assessing the students' pre-test and post-test answers and then calculating the increase that occurred using the gain test. Ability test thinks students understand process-solving problems in study. This is served in Table 1 following:

Table 1. Students' Thinking Ability Test in Understanding the Process Solution to the Problem

No.	Question Items
1	A cake seller is a type of cake-shaped rectangle long with a surface area of 96 cm. Before the cake is sold, significantly cut it into small pieces in parallelogram areas with 3 cm and 5 cm side lengths. Once cut, many cakes take shape parallelogram area, as many as six cakes. It turned out that a leftover cake had an oo-shaped area parallelogram from the cut. Wide area surface cake that does not shape area parallelogram is...
2	It is known that the ABCD kite has an area of 1,200 cm $^{2.}$ In addition, there are PQRS kites, each of which has twice the diagonal length. The diagonals of the kite ABCD. The area of the kite PQRS is …

Guidelines for scoring problem-solving based on the questions given refer to Table 2 as follows:

Table 2. Guidelines Scoring Solving Problem

Score	Understanding Problems	Designing Problems	Execute the Plan	Check again
5		Students plan according to mathematical (reasoning and modelling) procedures.	Students make plans with the procedure suitable and get the right result Correct.	
3	Participant educates fully understand the problem.	Students create plans but have not completed suit procedures (reasoning and modelling) for math.	Students plan with the proper procedure; however, No get computational results right.	Learners inspect to see the truth process.
2	Learners understand the problem partially the contents of the question.	Learners make plans partially that lead to the procedure; however, there are wrong formulas. Students understand the ideas of the problem, but their knowledge is insufficient, so they make the wrong procedure.	Students did some of the plans that led to the procedure, went wrong determine computing symbol so No get results Which Correct.	Students carry out examinati ons but No complete them.
0	Participant students do not understand the problem.	Students are wrong in designing plans. Students do not make plans.	Students do not carry out the plan.	Students do not do inspectio ns.

Source: [17]

Guidelines scoring assessed how much Far ability participants were educated to finish the two questions. Each question is then analyzed to compare the level of ability think students understand to solve process problems.

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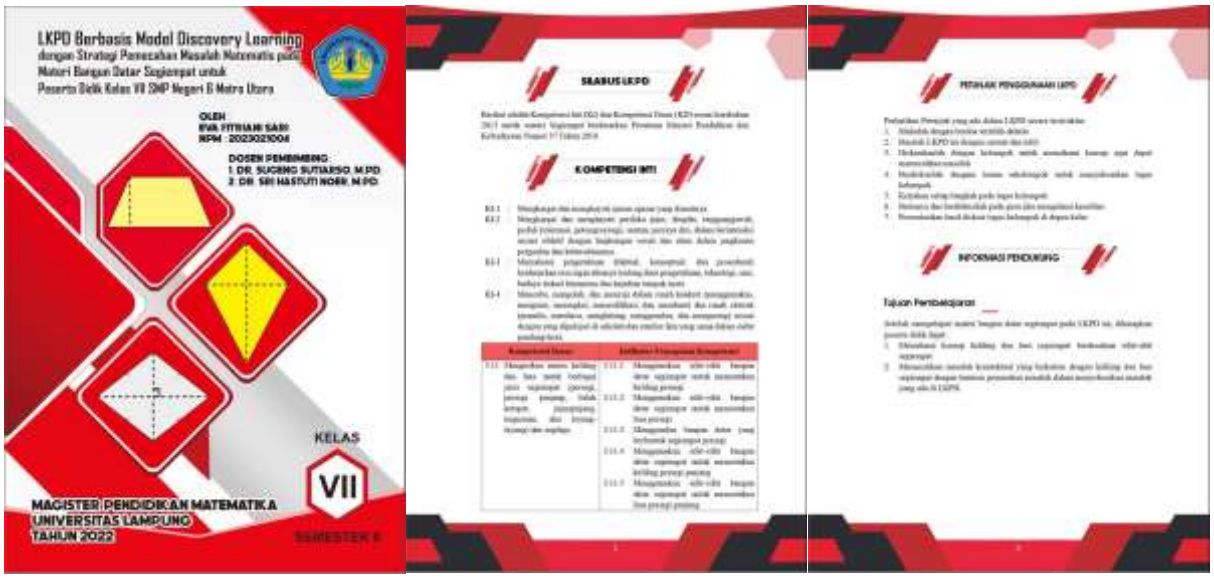
RESULTS AND DISCUSSION

The development of LKPD based on discovery learning starts from the definition, carried out by conducting field studies (interviews) with mathematics teachers. The results of field studies (interviews) show no teaching material based on scientific learning models that can train students' problem-solving abilities. Therefore, a solution emerged to develop teaching materials in the form of LKPD based on the discovery learning model, which can train students' problem-solving abilities because it is composed of elements that make it easier for students to solve problems. Discovery learning models are chosen because this model requires students to find solutions to the problems they face through systematic steps. This is to the research of [18], which states that applying the model of discovery learning assisted by student worksheets can train students' problem-solving abilities. The material that is the focus of this research is quadrilaterals. This material was chosen because quadrilateral is one of the materials that have many applications in everyday life.

The design stage is completed by compiling the research instruments used in this study. The instruments compiled consisted of material, media, and language expert validation sheets and their assessment rubrics. After the instrument is composed, it is followed by designing the initial design of the worksheet based on discovery learning. Discovery learning-based LKPD is prepared by integrating discovery learning steps and problem-solving indicators. The initial design of LKPD is based on discovery learning consisting of a cover, study guide pages, essential competencies and competency achievement indicators, a contents page, material contents and exercises. Then validation by materials, media, and language experts consisting of 2 mathematics lecturers.



(a) (b) (c)

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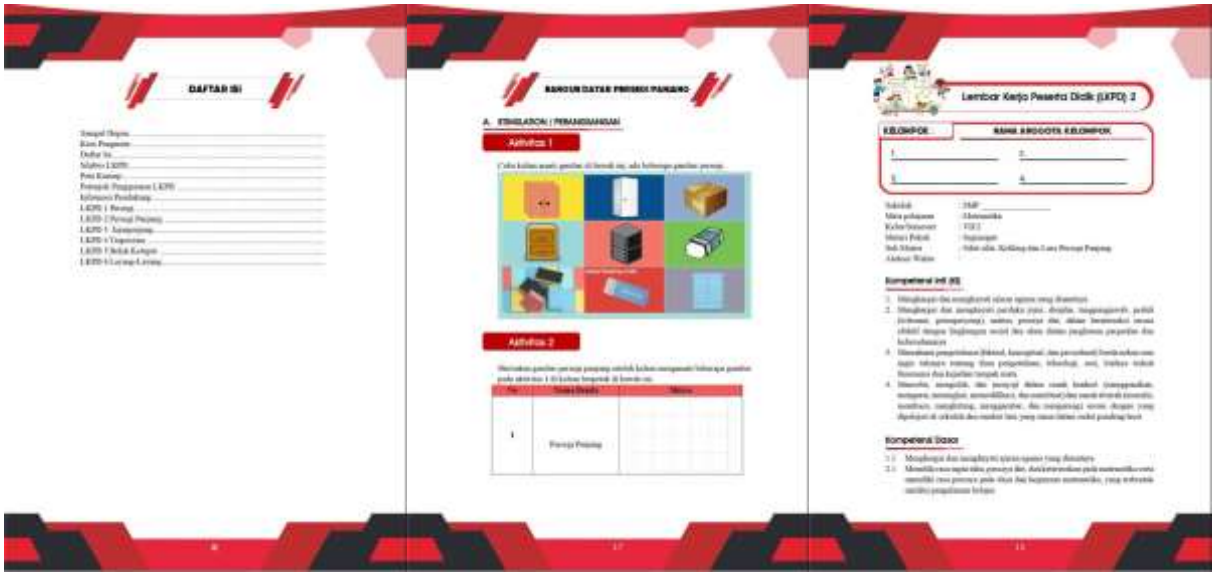

(d) (e) (f)

Figure 1. (a) Cover, (b) study guide pages, (c) essential competencies and competency achievement indicators, (d) a contents page, (e) material contents and (f) exercises

Following are the results of the validation carried out to determine the feasibility of the worksheet being developed.

Table 3. Material Expert Validation Results

No	Member Name	Score	Average	Eligibility Criteria
1	Dr. Nurhanurawati, M.Pd	72	0.89	Very Valid
2	Dr. Bambang Sri Anggoro, M.Pd	77	0.96	Very Valid

Table 4. Media Expert Validation Results

No	Member Name	Score	Average	Eligibility Criteria
1	Dr. Nurhanurawati, M.Pd	64	0.93	Very Valid
2	Dr. Bambang Sri Anggoro, M.Pd	62	0.90	Very Valid

Table 5. Linguist Validation Results

No	Member Name	Score	Average	Eligibility Criteria
1	Dr. Nurhanurawati, M.Pd	39	0.97	Very Valid
2	Dr. Bambang Sri Anggoro, M.Pd	38	0.94	Very Valid

Based on the validation results shows that LKPD is in an excellent category. These results prove that the developed LKPD is suitable for use in learning. However, input and suggestions from the validator are still considered as a basis for improving the developed LKPD before being tested on a small scale to measure the practicality of the developed product.

Smallscale trials were carried out by distributing LKPD to 6 students in class IX with rectangular material. When finished, students fill out a response questionnaire to assess the feasibility of the developed student worksheets. The following results of the recapitulation of student questionnaire scores are presented in Table 6.

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Table 6. Student Response Questionnaire Results

No	Component	Total score	Score Total	Average	Description
1	Display Aspect	183	192	0.95	Very Practical
2	Content/Material Aspects	109	120	0.90	Very Practical
3	Learning Aspects	217	240	0.90	Very Practical
4	Readability Aspect	106	120	0.88	Very Practical
Total Score		**615**	**672**	**0.90**	**Very Practical**

Then, continuing with individual trials, the researcher asked one of the mathematics educators at SMP Negeri 6 Metro Utara to assess the LKPD being developed. The recapitulation of educator questionnaire scores results are presented in Table 7.

Table 7. Results of the Educator's Response Questionnaire

No	Component	Total Score	Total Score	Average	Description
1	Display Aspect	29	32	0.89	Very Practical
2	Content/Material Aspects	19	20	0.94	Very Practical
3	Learning Aspects	39	40	0.97	Very Practical
4	Readability Aspect	20	20	1	Very Practical
Total score		**107**	**112**	**0.95**	**Very Practical**

Pre-test and post-test assessment of students to determine the value of students' problem-solving abilities given to the experimental and control classes. Calculating pre-test and post-test values through N-Gain obtained the data in Table 8.

Table 8. Value of Increasing Students' Problem-Solving Ability (N-Gain)

Learning	Mark	N	X_{min}	X_{max}	$\bar{x}$	Average N-Gain
LKPD Based Discovery Learning (Experiment)	Pre-test	30	20	70	43,83	0.54
	Post-test		60	90	74,83	
Conventional (Control)	Pre-test	30	20	65	44.50	0.40
	Post-test		60	80	68,17	

Based on the average results that have been calculated, it can be concluded that using discovery learning-based LKPD products can improve students' problem-solving abilities. This is the opinion of [14], showing an increase in problem-solving abilities and the completeness of problem-solving abilities taught by the discovery learning model.

Analysis of the causes of differences in students' mathematical problem-solving abilities is due to the existence of LKPD, which is composed of elements that make it easier for students to solve problems. In addition, the help of learning models can help improve problem-solving skills. The chosen model is discovery learning because it requires students to find the solutions to the problems they face through systematic steps. Based on the research that has been carried out, the use of student worksheets developed with groups using discovery learning models is higher than the learning outcomes of students with conventional models. With the LKPD based on discovery learning, students are familiarized with challenging problems to generate curiosity, which stimulates students to explore and investigate solutions to existing problems. This agrees with

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[19]. The discovery is that learning improves the quality of learning compared to conventional methods, and learners can improve their knowledge during the learning process [20]. The point is that discovery learning improves the quality of learning compared to conventional methods, and students can increase their knowledge during the learning process.

When solving problems, students are trained to explore ideas and build their knowledge independently without depending on educators. So that the discovery learning LKPD used provides an opportunity for students to build their problem-solving abilities. This aligns with [7] opinion that problem-solving ability is one of the goals in learning mathematics, namely to train ways of thinking and reasoning in concluding, developing problem-solving skills, and developing the ability to convey information or communicate ideas.

The advantages of teaching materials in the form of LKPD based on discovery learning can be seen in the learning process; namely, students become more active because they have LKPD, which can facilitate students to ask questions and listen. [21] states that the discovery learning model is one whose application will direct students to think critically. Learning activities will invite active students to identify independently from understanding a problem discussed in the study.

Based on the results of the author's analysis, with the difference in the results of the research that the researchers have carried out, the increase in mathematical problem-solving abilities is marked by students being able to answer the post-test questions better according to the steps that have been taught compared to when students work on the pre-test. This is because students have received all the material during the post-test. In addition, students have also received habituation to solve problems for events they encounter in life. This helps students to get used to working on the steps in solving a problem.

CONCLUSION

Based on the results of the research and discussion, it is concluded that the product resulting from developing a scientific-based LKPD to improve the problem-solving skills of SMPN 6 Metro Utara class VII after going through the validation stage, it can be concluded that the product is valid. After going through the field trial stage, it is concluded that the product is practically good regarding student and educator response questionnaires. Moreover, in terms of the completeness of the students' problem-solving abilities experienced an increase before and after treatment, it was concluded that the product was effective.

For teachers, because this scientific learning process cannot be developed for every topic or material, it is advisable to identify the materials and develop lesson plans and all the equipment components. The product that has been developed can be used as an example/reference for learning mathematics based on science to improve problem-solving abilities and student achievement. The learning that is developed is limited to quadrilateral material, so it is suggested that other researchers develop it on other subject matter or with different learning methods.

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