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# DEVELOPMENT OF SCIENTIFIC-BASED LKPD TO IMPROVE STUDENTS' PROBLEM-SOLVING ABILITY

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**ABSTRAK**

Penelitian ini bertujuan untuk mengetahui proses dan hasil pengembangan LKPD pembelajaran matematika berbasis saintifik yang memenuhi kriteria valid dan praktis, serta menguji kevalidan, kepraktisan, dan keefektifan LKPD yang dikembangkan. Penelitian dan pengembangan ini mengacu pada langkah-langkah Borg dan Gall. Subyek penelitian adalah siswa kelas VIII SMP Sains Qur'an Minhajuth Thullab Pekalongan Tahun Pelajaran 2022/2023. Teknik Pengumpulan data menggunakan wawancara, tes kemampuan pemecahan masalah, dan angket. Hasil penelitian menunjukkan bahwa bahan ajar LKPD yang dikembangkan terkategori valid (layak digunakan) berdasarkan penilaian validator ahli media dan materi. Selain itu, LKPD berbasis saintifik yang dikembangkan juga terkategori praktis berdasarkan penilaian siswa dan tanggapan dari guru matematika. Berdasarkan pengujian hipotesis dan proporsi, LKPD berbasis saintifik tersebut dapat meningkatkan kemampuan pemecahan masalah, namun belum efektif karena proporsi siswa yang memiliki kemampuan pemecahan masalah yang terkategori baik tidak lebih dari 60% dari jumlah siswa**.**

**Kata Kunci**: *Kemampuan Pemecahan Masalah, LKPD, Saintifik,*

**ABSTRACT**

*This study aims to determine the process and results of developing scientific-based mathematics learning worksheets that meet valid and practical criteria and test the developed worksheets' validity, practicality, and effectiveness. This research and development refer to the steps of Borg and Gall. The research subjects were grade VIII students of the Qur'an Science Middle School Minhajuth Thullab Pekalongan for the 2022/2023 academic year: data collection techniques using interviews, problem-solving ability tests, and questionnaires. The results showed that the LKPD teaching materials developed were categorized as valid (fit for use) based on the assessment of media and material expert validators. In addition, the developed scientific-based LKPD is also categorized as practical based on student assessments and responses from the mathematics teacher. Based on hypothesis testing and proportions, the scientific-based LKPD can improve problem-solving skills, but it is not yet effective because the proportion of students with good category problem-solving abilities is not more than 60% of the total number of students.*

**Keywords**: *Problem-Solving Ability, Scientific, Students Worksheet,*

## INTRODUCTION

Ministry of National Education (2013) in Law Number 20 of 2003 concerning the National Education System, Article 1 paragraph 1 states that Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have spiritual strength religion, self-control, personality, intelligence, noble character, and skills needed by himself, society, nation, and state.

According to Mashuri, S. (2019), mathematics is a universal science that has a vital role in various disciplines, develops human thinking power, and underlies the development of modern technology. Therefore mathematics education must be taught and developed at every level of education. The complexity of real-life problems and the need for appropriate solutions so that mathematics must be provided to students so that they have critical, creative, and logical abilities. So mathematics is essential in forming a thinking ability to solve a problem well (Hartati et al., 2017). From this, we can see that mathematics is not just a "subject" we encounter in education.

Therefore, the world of education requires innovations through advances in science and technology without neglecting human values. To improve the quality of education in Indonesia, one of the government's efforts is to improve the education curriculum at various levels. One form of improvement in the current education curriculum is the enactment of the 2013 curriculum, which was developed based on internal and external challenges to realize educational goals. One of the emphases in the 2013 Curriculum is the development of student problem-solving skills.

Based on observations and interviews with teachers and students of Minhajuth Thullab Pekalongan Qur'an Science Middle School, information was obtained that solving mathematical problems was still low. One of the causes of students' weak problem-solving skills is the unavailability of student worksheets that emphasize experimental and observational activities based on a scientific approach. Therefore, we need appropriate learning media to foster and cultivate students' scientific attitudes. The following are students' answers to the SPLDV material.

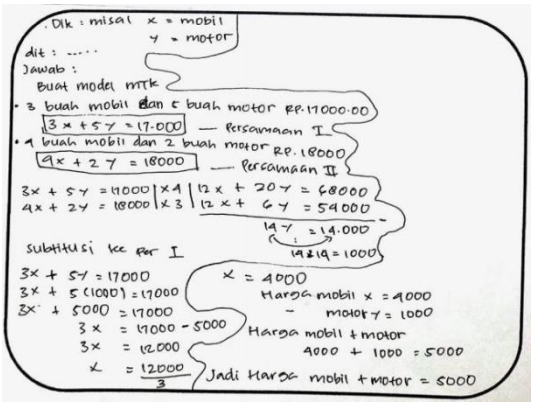


**Figure 1.** Student Answers 1

In Figure 1, one of the students' answers shows that students identified known elements but did not identify the elements in question, whereas, in the first indicator, the priority was identifying elements that were known, asked and the adequacy of the elements needed. Even so, students work on detailed solutions, from modeling and eliminating to substituting. However, in the final results, it seems that the students were not careful with what was ordered in the questions, so their answers were wrong.

Learning mathematics places problem-solving abilities as an essential indicator of improving students' critical and creative abilities. As the goals of learning mathematics, according to the Minister of Education and Culture, namely, students can do problem-solving, including understanding problems, designing models, solving, and interpreting solutions, Latifah & Luritawaty (Sriwahyuni & Maryati, 2022). This opinion was similarly expressed by Amalia, et al. (2022), that the formation of students' mathematical understanding will benefit students if it involves solving problems that occur in everyday life.

Hartinah, et al. reinforce this statement (Sriwahyuni & Maryati, 2022) Problem-solving ability is a learning process that arouses students to play an active role so that they can receive and respond to questions that are appropriately submitted and can overcome difficulties in solving a problem.

The importance of problem-solving abilities in mathematics was also conveyed by (Hendriana & Soemarmo, 2019), which stated that the problem-solving process in mathematics is one of the basic mathematical abilities students must have. However, the ability of students to solve mathematical problems is low. (Nurasyiyah, 2014) states that the low ability to solve math problems is due to the lack of involvement of students' awareness in learning. Many people understand mathematics but do not realize that mathematics is synonymous with problem-solving.

Several indicators of problem-solving abilities were put forward by Polya (Kurniawati & Sutiarso, 2022), as follows, namely (1) understanding the problem, it can be measured if students can formulate problems (2) planning problem-solving by preparing strategies used to solve problems, (3) implementing problem-solving strategies and (4) *looking back* (checking again), namely testing the correctness of answers.

Various efforts were developed to improve the quality of learning. One way to do this is to develop learning media as teaching materials. Suryosubroto (2009) said that providing various teaching media will be very useful for children to learn according to different ways of learning. Renewal of the teaching system towards *Individualized Instruction* has been implemented, including programmatic teaching and teaching with LKPD. Learning materials have a significant role in learning activities. According to Sungkono et al. (2003), learning materials contain learning material or content designed to achieve learning objectives. Teaching materials are systematic, arranged sequentially to make learning easier for students.

According to BSNP (2007), teaching materials, in general, consist of knowledge, skills, and attitudes that students must learn to achieve predetermined competency standards. According to Finch & Crunkilton (2006, 208-232), teaching materials can assist teachers in bringing about desired behavioral changes in individual students. There are several teaching materials as curriculum materials, namely: printed teaching materials, audio-visual materials, and manipulative aids. Teaching materials are systematic, arranged sequentially to make learning easier for students. One source of teaching materials that can be used is LKPD.

## METHOD

This type of development or Research and Development (R&D) aims to produce specific products and test the validity of these products (Borg & Gall, 1989). This research was conducted at the Minhajuth Thullab Qur'an Science Middle School, Pekalongan, in the odd semester of the 2023/2024 academic year. The R&D model used in this study is a development model that refers to the development procedures of Borg & Gall (1989) through several modifications. (1) Preliminary study subjects conducted needs analysis through observation and interviews in the preliminary study. Subjects at the time of observation were students of class VII. Subjects at the time of the interview were teachers of Mathematics Science Middle School Qur'an Minhajuth Thullab Pekalongan, (2) Subjects of validation of learning development, subjects of validation of learning development in this study were two experts consisting of one material expert, one media expert for material development teach. (3) The small class test subjects, the subjects at this stage, were taken by ten class VII students who would take the material on a system of two-variable linear equations to test the product's practicality. (4) All class VIII students at this stage were Field trial subjects and experimental class trial subjects.1 Minhajuth Thullab Qur'an Science Middle School Pekalongan and control class test subjects were all class VIII students.2 Minhajuth Qur'an Science Middle School Thullab Pekalongan to test product effectiveness. There are ten stages

of the Borg & Gall development model, including (1) Preliminary Study; (2) Planning; (3) Development of Initial Product Design; (4) Preliminary Field Testing; (5) Revision of Main Product Revision; (6) Main Field Testing; (7) Operational Product Revision; (8) Operational Field Testing; (9Final Product Revision; (10) Dissemination and Implementation.

The instruments used in this study consisted of two types: non-test and test. The non-test instrument used in this study was a questionnaire in the form of a *Likert scale.* This instrument is used to obtain data regarding the opinions of experts (validators) on the eligibility of the prepared LKPD. The test that will be carried out in this study is in the form of an essay *test.* The results of the student description test will be given a score according to the scoring criteria.

**Table 1** Aspects of Problem-Solving Ability Student Mathematics

| No. | Indicator | Information | Score |
|---|---|---|---|
| 1. | Understanding Problems | Students do not say anything | 0 |
| | | Students write down data/concepts/knowledge that are not related to the problem posed so that students do not understand the problem posed | 1 |
| | | Students only write down (express) what is known or asked | 2 |
| | | Students can write down (express) what is known and asked from the problem posed correctly | 3 |
| 2. | Planning problem solving | Students do not tell or write down the steps to solve the problem | 0 |
| | | Students tell or write down the steps to solve the problem but do not coherently | 1 |
| | | Students write down sufficient conditions and necessary conditions (formula of the problem posed and use all the information that has been collected) | 2 |
| 3. | Carry out the plan | Students are not able to carry out the plans that have been made | 0 |
| | | Students carry out the plans that have been made, but there are procedural errors and calculation errors | 1 |
| | | Students carry out the plans that have been made, but procedural errors occur | 2 |
| | | Students carry out the plans that have been made and use the steps to solve the problem correctly, no procedural errors occur, but calculation errors occur | 3 |
| | | Students carry out the plans that have been made and use the steps to solve the problem correctly, no procedural errors occur, and no calculation errors occur. | 4 |
| 4. | Check again | Students do not re-check answers | 0 |
| | | Students check their answers again | 1 |

(Widodo, 2013)

Before the problem-solving ability test instrument is used during the field test, the test is validated and then tested in a trial class, class IX A, to determine reliability, difficulty level, and distinguishing power. The following is an explanation of these stages. From the test results, then the data is tested using the *gain normality test* (*N-Gain*). This test determines the interpretation of the increased student's conceptual understanding abilities after using the learning module.

The results of calculating the N-Gain value (g) are then classified using the following classification.

**Table 2.** Classification of Increase Count Results

| Gain Value | Interpretation |
|---|---|
| $G \geq 0.7$ | High |
| $0.3 \leq g < 0.7$ | Medium |

| | |
|---|---|
| $0 < g < 0.3$ | Low |

The module is practical if the data results show an increased ability to understand students' mathematical concepts and include a "medium" or "high" interpretation of the *N-Gain classification.* (Saddadi in Ats-Tsauri, 2020)

## RESULT AND DISCUSSION

The preparation of LKPD begins with compiling scientific-based learning stages that will be implemented in LKPD. The next step is to plan to compile scientific-based LKPD based on scientific learning stages that are adjusted to the core competencies and essential competencies in the KTSP curriculum. LKPD is arranged sequentially, consisting of a title page, inside cover page, preface, SK-KD and learning objectives, and learning activities 1 to 6, which contain material titles, descriptions, and practice questions. The results of the data analysis carried out on the development of LKPD are described as follows:

**1. LKPD Quality**

**a. validity**

The validity criteria of LKPD were obtained from the results of the validation analysis carried out by material experts and media experts on scientifically based LKPD designs to improve students' problem-solving abilities with content and construct valid categories with a total score obtained from the material validator is 67 out of a maximum total score of 72. In contrast, media experts gave it a 62 out of a total score of 64.

**b. Appropriateness**

Questionnaire scores for the components of the eligibility aspect of the content and presentation of the students obtained an assessment in the excellent category with a total score of 49.50 from the score of a maximum of 60. At the same time, the partner teacher assessed with a score of 90 out of 100, included in the excellent category, so it can be concluded that the eligibility criteria for LKPD have been achieved in Table 3.

**Table 3.** Teacher Response Questionnaire Results

| No. | Component | Average Score | Max Score | Rating Category |
|---|---|---|---|---|
| 1 | A | 20 | 24 | excellent |
| 2 | B | 20 | 24 | excellent |
| 3 | C | 24 | 28 | excellent |
| 4 | D | 22 | 24 | excellent |

**c. effectiveness**

The effectiveness of scientific-based LKPD is viewed from 2 (two) aspects, namely: (1) Completeness of Learning Outcomes. The results of the analysis of students' mastery of learning towards the ability to solve mathematical problems from LKPD to LKPD showed a significant increase. In LKPD 1, 27 students achieved completeness (75%) of 36 students. In LKPD 2, 29 students achieved completeness (81%) of 36 students. (2) Student Response. Student responses to LKPD showed that more than 80% were in a positive category. From the analysis of the effectiveness of LKPD, it can be concluded that the LKPD developed meets the criteria for being effective.

**2. Data Analysis of Increasing Students' Problem-Solving Ability**

Preliminary data on students' mathematical problem-solving abilities in the experimental and control classes were obtained from the pretest results carried out at the beginning of the meeting. The results of the pretest data analysis in the two classes have the same initial ability to solve mathematical problems. Table 3 shows the average score of students' initial mathematical problem-solving abilities.

**Table 4.** Initial Score Data for Students' Problem-Solving Ability

| Class | Student | Lowest Score | Biggest Score | Average Score |
|---|---|---|---|---|
| Experiment | 25 | 25 | 45 | 35.17 |
| Control | 27 | 32 | 48 | 36.22 |

After the learning, a final mathematical problem-solving ability test was carried out in the experimental and control classes. The data from the posttest results are needed to calculate the gain index of mathematical problem-solving abilities and to analyze the achievement indicators of students' mathematical problem-solving abilities after learning.

The average mathematical problem-solving ability of students who use scientific-based LKPD is 76.32, while students whose learning does not use scientific-based LKPD get an average score of 66.03. The average gain index for students' mathematical problem-solving abilities using scientific-based worksheets was 0.62, included in the increase with moderate criteria; for the control class, the increase in mathematical problem-solving abilities was included in the increase with low criteria, namely 0.23. In addition to providing a quantitative assessment, the validator also provides comments and suggestions for improvements to the LKPD being developed. Comments and suggestions from the validator are used as a reference for revising the LKPD. Based on comments and suggestions from material experts regarding Islamic integration with SPLDV material, especially the integration of Islamic values, it was declared excellent and feasible for the next stage. Moreover, here is a picture of the Scientific Approach-Based LKPD. Thus, the developed LKPD is ready to be tested in the field, and further research can be carried out to see the effectiveness of the LKPD.

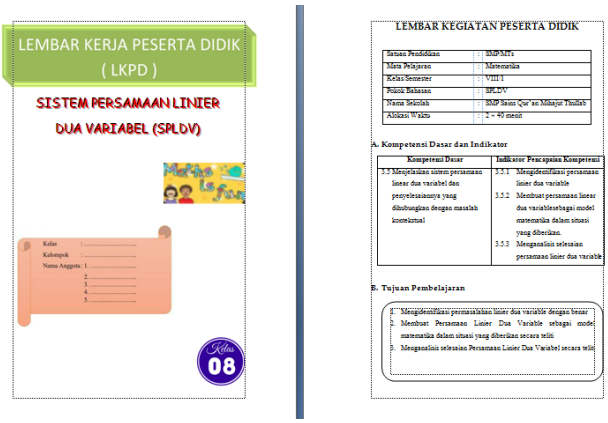


**Figure 2. LKPD Before Validation**

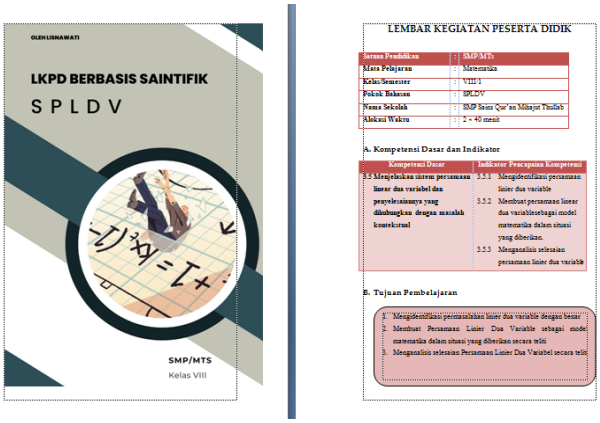


**Figure 3. LKPD After Validation**

In terms of student activity, there is an increase in active student activity. In LKPD, I observed active student activity that is not yet at the specified tolerance limit. In the next LKPD, all student active activity observation categories are already at the specified tolerance limit.

Suppose it is related to the activities of students in implementing scientific-based learning models with Piaget's theory. In that case, it states that social interaction in learning activities, both with friends in a group and outside the group, significantly influences students' thinking. Through this interaction, students can compare the thoughts and knowledge they have formed with the thoughts and knowledge of others. In another section, John Dewey (Trianto: 2009) explains that problem-based learning is the interaction between stimulus and response, a relationship between two-way learning and the environment. The environment provides input to students through help and problems, while the brain's nervous system interprets the aid effectively to investigate, analyze, and resolve the problem. With the conditions, processes, and learning activities above, it is expected to provide opportunities and make students independent learners.

Scientific-based LKPD can improve the teacher's ability to manage learning. This fact can be seen from the activities of students during group learning using scientific-based LKPD. Students look very active in completing every task in the LKPD. The teacher only directs and provides guidance when needed.

When it is associated with the learning theory stated by Vygotsky (Anwar: 2008) that the problem-based learning model emphasizes *scaffolding,* namely providing a large amount of assistance in the form of questions when there is stagnation in thinking, then reducing this assistance gradually and allowing students to take over the greater responsibility after the learner can do it.

Based on the explanation above, the teacher's task is to provide direction and help students to explore information in solving mathematical problems and dealing with meaningless information. Teachers encourage students to interact and work together among students and create a learning climate that respects each other between teachers and students or other fellow students.

Parkay's opinion (Aryati: 2012) is that the teacher's role in learning is only as a facilitator and organizer who only manages the activities of students, giving directions so that the material being studied is easy to understand and interpret. The role of the teacher as a facilitator is to facilitate and accommodate the diversity of students' mathematical abilities because students' intelligence levels vary, so the difficulty level of students in solving mathematical problems also varies greatly. By dividing students into groups, there will be interaction and cooperation between students as ideas in solving mathematical problems. Based on the description above, it can be concluded that learning with the help of scientific-based LKPD can improve the teacher's ability to manage learning.

The results of the questionnaire analysis of student responses to LKPD concluded that students had a positive response to the components and appearance of LKPD. The positive response of students is inseparable from the conditioning of learning with scientific learning models, including the problems posed to students originate from scientific problems, namely problems that are close to the real world of students or can be reached by the imagination of students to show the usefulness of mathematics in students' lives through problem-solving.

Soedjadi (Sinaga, 2007) argues that setting real problems in the implementation of learning mathematics must always pay attention to reality and the existing environment, to enable and motivate students to enjoy learning mathematics.

Student responses to LKPD meet excellent criteria. This indicates that the application of learning tools developed oriented to problem-based learning models can foster students' motivation and interest in learning in carrying out learning.

Mathematical problem-solving ability is the ability of students to 1) understand problems related to the material, 2) make and design problem-solving, 3) be able to solve problems, and 4) be able to re-examine problems. The increase in students' mathematical problem-solving abilities can be seen from the post-test results in the experimental and control classes—the post-test scores results of the two classes are in Table 5.

**Table 5.** Final Value of Problem-Solving Ability

| Class | Lots Student | Lowest Score | Biggest Score | Average Score |
|---|---|---|---|---|
| Experiment | 25 | 58.14 | 92.54 | 76.32 |
| Control | 27 | 40.72 | 82.13 | 66.30 |

From the average post-test value, it was obtained that the N-Gain of the experimental class was 0.62 in the medium category, while the control class obtained an *N-Gain* of 0.32. Thus it can be concluded that scientific-based LKPD effectively increases students' problem-solving abilities.

LKPD guides students in investigative or problem-solving activities (Trianto, 2010). The LKPD uses practice questions developed with various models or approaches to direct and guide students in solving problems. The LKPD contains instructions and steps to solve the problem. The problems given in LKPD must be clear about the essential competencies to be achieved.

Learning with a scientific approach is a learning process designed in such a way that students actively construct concepts, laws, or principles through the stages of observing (to identify or find problems), formulating problems, submitting or formulating hypotheses, collecting data with various techniques, analyzing data, draw conclusions and communicate concepts, laws or principles that are “found” (Kemendikbud, 2013). The scientific approach is intended to provide understanding to students in knowing and understanding various materials using a scientific approach that information can come from anywhere, at any time, not depending on unidirectional information from the teacher so that students will be more independent. Therefore, the expected learning conditions are directed at encouraging students to learn from various sources through observation and understanding of concepts in a material. So we need scientific-based teaching material in the form of LKPD. Therefore, researchers are motivated to conduct research in developing scientific-based mathematics learning worksheets to improve students' problem-solving abilities.

## CONCLUSION AND SUGGESTION

Based on the results of data analysis and discussion, it is concluded that scientific-based LKPD-assisted learning that has met valid, reliable, and practical criteria is very effectively applied in improving mathematical problem-solving abilities in terms of students' responses to LKPD, student activities in learning, ability improvement students in solving problems that exist in KLPD, as well as increasing the achievement of mastery learning outcomes.

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