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Development of Student Worksheets Based on Problem Based Learning Models to Improve Problem Solving Ability

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ABSTRACT

In order to enhance problem-solving abilities, this study intends to describe the validity, practicality, and effectiveness of student worksheets based on problem-based learning models. Analysis, Design, Development, Implementation, and Evaluation are the five stages of the ADDIE development paradigm, which is used for development research. Class VIII pupils from Medan State's 4 MTs Preparation for the academic year 2022/2023 served as the study's subjects. An assesment of problem-solving skills combined with a description exam serves as the research tool. There were two trials in this study: trial I was class VIII-3 and trial II was class VIII-2. The findings revealed that: 1) problem-based learning worksheets for students were deemed valid by validators with an average value of 4.06; 2) problem-based learning worksheets for students were deemed practical based on experts and the implementation of learning with the implemented category good; and 3) problem-based learning worksheets for students were deemed effective based on: a) classical completeness which reaches 84.00%, b) student response to learning is 93%, and c) increasing problem solving abilities based on N-Gain values of 0.50 is in the middle range.

A. INTRODUCTION

Learning is a process of change achieved by students when learning takes place to develop their potential so as to achieve educational goals. According to Yusuf (2018) educational goals that can be achieved are: national, institutional, curricular, and instructional goals. In achieving an educational goal required a professional teacher. So that educational goals can also be achieved through evaluation in the cognitive, affective cognitive and motor areas which are better in facing the challenges of today. In this case, one of the lessons that is important for MTs Students are instructed in maths. mathematics as stated by Johnson and Rising in (Susilawati, 2020) is a pattern of thinking, organizing and proving logically in which mathematics is clear and accurate with symbols. Therefore mathematics has a significant impact on daily lives. that requires ability.

Mathematics learning is deemed effective if the intended learning outcomes are accomplished. Where the goals of learning mathematics according to the National Education Ministry (Setiana & Nuryadi, 2020) must be directed to more comprehensive goals, according to the requirements of the curriculum. Based on the earlier, it shows that the reason and purpose of learning mathematics is that mathematics subjects need to be given to all students from elementary school to a higher school level. However, the kids' accomplishments reveal that their mathematics skills have not been at their best. This can be seen in the 2018 PISA report that the ability of mathematics in Indonesia was last ranked 72 out of 78 countries. The mathematical abilities of Indonesian students are ranked in the lowest five countries, for the first rank is obtained by China with a score of 591, while Indonesia gets a score of 379 (Schleicher, 2019). This is a big challenge for teachers in teaching mathematics.

Teaching mathematics is not just the teacher preparing and conveying rules and definitions, as well as procedures for students to memorize, but how the teacher involves students as students who actively participate in their education in an effort to motivate them to create or develop their knowledge. Based on the results of the researchers' initial observations that students were less interested in learning mathematics because students considered that mathematics was difficult to understand and not interesting to study. This is a result of the learning process's lack of creativity. This also causes students to have difficulties in the process of learning mathematics when faced with problems. Where students do not understand if the question does not follow the

teacher's example. These pupils are confused because of what initial steps students should take to solve the given problem. It also makes students feel uninterested in the learning process because students already think that mathematics is in the form of numbers that are difficult to solve.

The researcher also received information that the mathematics teacher was more dominating that pupils were less engaged in the learning process as a result and did not hone their thinking to ask questions that they did not know because the teacher did not really provide space for students to give an opinion in the ongoing mathematics learning process.

The capacity to solve mathematical puzzles is one of the skills that students studying mathematics must possess. Problem solving is a process of solving or solving a problem by using procedures to get the expected solution. In mathematics, what is referred to as a problem usually describes non-routine questions where reasoning skills, creative thinking and critical thinking are needed to solve them. This is in line with Hendriana, et al.'s (2017) assertion that "learning problem solving helps students learn to think and reason and helps in developing other mathematical abilities including creative thinking and critical thinking".

In this case, students must also have problem-solving skills to prepare students for coping with a variety of challenges, including increasingly complicated problems in daily life, other academic disciplines, and mathematics. In order for students to overcome the challenges they encounter, it is necessary to consistently train their ability to solve mathematical problems. According to Charles, Lester, & O'Daffer, students are considered to be capable of solving mathematical issues, specifically: (1) Recognizing the issue (understanding problem); (2) organizing mathematical issue (solving the problem); (3) Solve the problem (answer the problem). It is clear from the previous definition that issue solving abilities make a major contribution to the success of students learning mathematics. In addition, problem solving abilities also receive recommendations from mathematics education experts to grow and advance further among pupils.

In actuality, pupils' capacity for solving mathematical puzzles is still somewhat limited. Considering the outcomes of observations and tests of problem solving skills conducted by Rahmmatiya & Asih (2020) stated "Students at SMPN 160 Jakarta are known that student problem solving is still low, especially in class VII-B, on the results of the students' midterm assessment scores which achieving KKM is only 18% and those who do not reach KKM are 82%. This is also because most students in dealing with problem solving are still weak. Where students tend not to want to try to ask the teacher and friends. Additionally, pupils will struggle to use their knowledge to solve genuine challenges or non-routine problems that are connected to the topics they have acquired. This is what contributes to kids' poor problem-solving skills.

based on findings from study observations obtained on Saturday, March 26, 2022 in class VIII MTs Negeri 4 Medan preparation. The results of exams using problem-solving material for a system of linear equations with two variables show how poorly pupils can solve mathematical issues. The results of the exam for problem-solving skills revealed that none of the kids met particularly high standards, there was 1 student with high criteria, there were 4 students with moderate criteria, there were 13 students with low criteria and there were 10 students with very low criteria. Based on the overall average of 40.18%, it can be stated that pupils' problem-solving skills are still subpar.

Based on the description above, It is clear that children have poor problem-solving skills. This is so because the teacher still uses a traditional, direct learning approach. According to the researcher's interview with a mathematics teacher at MTs Preparation Negeri 4 Medan on Saturday, March 26, 2022, he claimed that learning activities went on as usual, the teacher explained the subject matter, and the students listened to his explanation before receiving practice questions. The most essential thing is that the explanation of the content reaches students and that students can absorb the knowledge offered by the instructor. Learning activities cannot be carried out in line with the current RPP. The teacher must work to improve these circumstances in order to address the issues that arise during the process of learning mathematics at school, particularly in students' mathematical aptitude and dispositions that lead to poor learning outcomes in mathematics. Improvements have been made to the teaching resources.

The most crucial tools for learning are learning gadgets crucial to the educational process. This is because in the process of learning required effective, efficient and structured learning with the existence of a learning tool. Learning tools used by teachers in teaching according to Sinaga (2020), namely: "Effective Week Analysis, Annual Program, Semester Program, a syllabus, a learning implementation plan, a learning outcomes test, a learning outcomes test, student worksheets, evaluation tools, learning media, and student textbooks". Another issue that should be taken into consideration by teachers and should be owned by every instructor without exception is the use of learning technologies.

According to the claims and findings of experts in the field, one of the reasons why students at school have low problem-solving skills and mathematical dispositions is because teachers don't provide them with adequate

teaching resources, which makes learning less efficient. Based on the researcher's conversation with the math instructor at MTs Preparation Negeri 4 Medan on Saturday, March 26, 2022, this assertion was made. revealing that the existing student worksheets are a sort of educational resources had not been optimally implemented. This is because the student worksheets used by students in the process of continuing education were taken by the school from the publisher cv. river library.

A teacher must be able to compile student worksheets for their students according to the needs of students through student worksheet procedures. This is because student worksheets provide information that cannot be conveyed by the teacher orally. However, the teacher was unable to compile his own student worksheets, the learning process did not follow the guidelines for creating student worksheets. If seen from the student worksheet above, from the aspect of color and the design of the student worksheet, It has failed to engage pupils' interest in studying, causing them to become disinterested, not interested in reading it and are lazy to work on the student's worksheet if not to get a grade. The student worksheets used contain little material and routine questions so they are not used effectively in the learning process because they seem monotonous, there are no activity steps that can train thinking processes and improve students' problem-solving abilities.

Student worksheets are learning tools as a means of supporting the implementation of lesson plans. Using student worksheets will provide students more chances to participate actively and creatively in their education. In order to develop students' abilities, such as learning innovations through problem-based learning models, student participation in the learning process is required. As a foundation for learning, the problem-based learning paradigm exposes students to real-world issues and encourages them to solve them. The problem-based learning model is also known as the problem-based learning model because it encourages students to use higher order thinking skills to solve the issues that are presented (Saefuddin & Ika, 2014). This is also supported by Sumanti in (Kurniasari, et al., 2020) that the problem-based learning approach encourages students to take an active role in their education and spurs students to think at a higher level because students associate a problem and then solve the problem so that from solving a these problems students learn skills. Additionally, this educational method aids pupils in processing previously learned material and building their own understanding of the social world and its surrounds. where learning is appropriate for acquiring both fundamental and complicated information. Therefore, problem-based learning worksheets for students can help them develop their problem-solving abilities.

B. RESEARCH METHODS

The ADDIE development model is used in this research as part of development research. This model's development process is divided into five stages: analysis, design, development, implementation, and evaluation. This model was chosen because it makes an effort to develop products that are designed and then tested for viability using validity to determine the extent to which students' mathematical problem-solving skills have improved with worksheets based on problem-based learning models. The development model in this study is schematically described in the following chart in Figure 1.

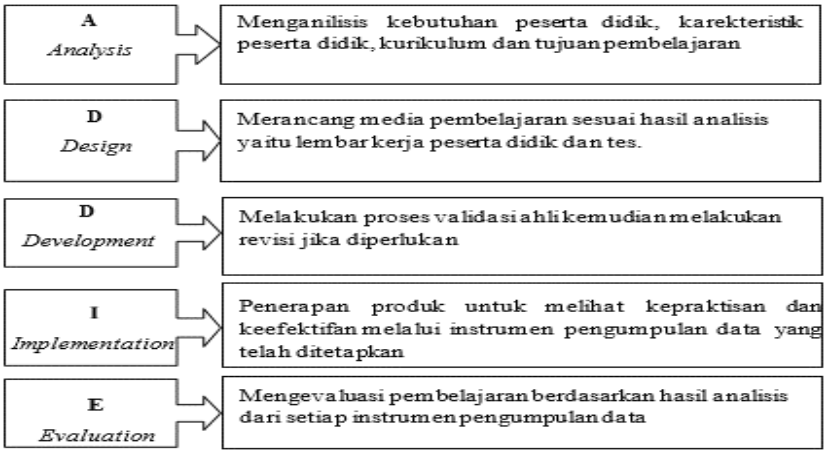

Figure 1. **ADDIE Development Model Stages**

Using the phases of building a model previously, the research was carried out at MTs Preparation Negeri 4 Medan, which is located on Jl. Jala Raya Besar, Kec. Medan Labuhan, Medan City, North Sumatra 20251. The reason for choosing the research location. So far, learning mathematics at this school still uses conventional learning models where the role of the teacher is more dominant than that of students. This research schedule

is carried out in the 2022/2023 academic year in odd semesters. The participants in this study were class VIII students, while the purpose of this research was student worksheets generated based on problem based learning models to increase students' mathematical problem solving abilities in the area of a system of two-variable linear equations. Where is the quality of growth by looking at validity, practicality and effectiveness in the learning process.

RESULTS AND DISCUSSION

This development research with the ADDIE development model can be seen in the process, namely:

Analysis Stage

The analysis phase involves the stage where the researcher analyzes the need developing learning tools and analyzing eligibility and requirements development at Mts Negeri 4 Medan. The stages of analysis carried out in this study include four things, namely analysis of the needs of students, analysis of pupil personalities, program analysis, and developing learning objectives. Broadly speaking, the stages of analysis carried out in this study are as follows: a) The teacher's inadequate utilization of teaching resources, as determined by an examination of the requirements of the students, negatively influences the students' inability to solve problems, b) analysis of the character of students, seen from cognitive development, academic abilities, and socio-economic background of students, c) curriculum analysis, seen from the material linear equations of two variables referred to in the 2013 curriculum based on KI, KD, and achievement indicators, and d) formulation of learning objectives, useful For summarizes results from analysis draft And analysis task For determine behavior object study. The production of education objective or indicators of attainment of education results is based on core skills and indicators mentioned in the program about anything the material notion of linear equations of two variables.

Design Stage

The design stage is to design learning tools in the form of student worksheets, so that examples of learning devices are obtained for material systems of two-variable linear equations based on problem-based learning models. At this stage, tasks include exam preparation, media selection, format selection, and preliminary learning device design. Following is a description of each activity's findings during the design stage: a) preparation of the test, using a problem-solving ability test consisting of four items, b) selection of media, using student worksheet media based on problem-based learning models on system material linear equations of two variables in class VII I MTs Preparation Negeri 4 Medan are media adapted to concept and task analysis, c) The study's choice of format, which was tailored to the 2013 program. The learning strategy included a list of core competencies, fundamental skills, acquiring indicators, goals for learning, materials for learning, instruction, evaluation and instruction resources, instructional methods, time allotment, tests, in addition to answer sheets and achieving recommendations, all in keeping with the 2013 program. There are three types of learning activities: opening, core, and closure. While the student worksheet format is colored so that students will be interested and motivated to learn. For the format of the problem solving ability test refers to the indicators of each problem solving ability, d) a learning implementation plan, student workbooks for three meetings, examinations of students' problem-solving skills, scoring instructions, and answer keys comprise the learning device's initial design.

Development Stage

The analysis and design phases led to the creation of draft I, the first design of a learning tool. Validating draft I with specialists came first in the development stage, followed by field tests. Format, content, graphics, and language in learning aids built on the created problem-based learning paradigm are the main areas of expert validation. The outcomes of expert validation take the form of validation values, corrections, critiques, and suggestions, all of which serve as a foundation for the development of improved learning aids. The learning tool that emerged from the modification is referred to as draft II and has satisfied the necessary standards. Validation is an important part of developing learning tools to correct errors and weaknesses in the design. A summary of the results of validators 3 lecturers and 2 teachers regarding learning tools is found in table 1.

Table 1 summarizes the validation of expert learning tools.

Table 1. Learning Device Validation

Validated instrument	Score	Category
Lesson plan	4,14	Valid
Student Worksheets	4.06	Valid
Problem Solving Ability Test	Minor Revision	

Based on table 1, If the learning device falls within the range $3 \leq Va < 4$ it is said to be valid.

Implementation Stage

After the developed learning device meets the valid criteria, it is then called draft II. So this II draft is ready to be tried out at the research site, namely MTs Preparation Negeri 4 Medan, referred to as trial I in class VIII-3 and trial II in class VIII-2 from here on. This can be seen in the description of the outcomes of tests I and II, namely:

1. The practicality of student worksheets
   a. Assessment of student worksheet experts/practitioners states that problem-based learning student worksheets can be used with minor revisions
   b. Analysis of According to the observation of learning implementation, trial I's value of implementation of learning was 2.89. which was in the low category or not implemented properly. Whereas in trial II the value of learning implementation was 4.01 in the low category or well implemented.
2. The effectiveness of student worksheets
   a. Classical mastery of students' learning, Once before the teaching and learning activities begin, known as the pre-test, and once at the conclusion of the lesson after completing three sessions of teaching and learning activities, known as the post-test. A system of two-variable linear equations is the subject matter of the pre-test and post-test, which are provided to assess the improvement in mathematical problem-solving skills attained by students after being exposed to problem-based learning methods. As can be seen in this instance, trial I's average posttest score was 77.188, while trial II's average posttest score was 82.125. Understanding the problem was the lowest indication of problem solving skill in trial I, as well. In order to demonstrate the traditional completeness in trials I and II. The findings of the classical completion in trial I of the problem solving ability test in the pretest and posttest phases of the learning process are summarized in table 2.

Table 2 summarizes the classical completeness in trial I.

Table 2. Pretest and Posttest Classical Completeness Levels of Problem Solving Ability in Trial I

Category	Pretest	Percentage of Classical Mastery	Posttest	Percentage of Classical Mastery
	Number of Students		Number of Students	
complete	7	28.00%	15	60.00%
Not Completed	18	72.00%	10	40.00%
Amount	25	100%	25	100%

The findings of the classical completion in trial II of the problem solving ability test in the pretest and posttest phases of the learning process are summarized in table 3.

Table 3 summarizes the classical completeness in trial II.

Table 3. Pretest and Posttest Classical Completeness Levels of Problem Solving Ability in Trial II

Category	Pretest	Percentage of Classical Mastery	Posttest	Percentage of Classical Mastery
	Number of Students		Number of Students	
complete	10	40.00%	21	84.00%
Not Completed	15	60.00%	4	16.00%
Amount	25	100%	25	100%

Based on tables 2 and 3 Above, it can be said that trial II demonstrated that pupils had fully acquired their knowledge of how to solve problems, this is the achievement of effectiveness in the learning process.

   b. Student response. One way to see the effectiveness of a student worksheet is to look at student responses. The student response data aims to see the extent to which students are interested, happy, up-to-date, and With the creation of the problem-based learning paradigm, it is simple to grasp the elements of student worksheets. A student response survey about the learning tools and implementation was completed by 25 students from classes VIII-3 and VIII-2 after the posttest was completed. Data on student responses

was gathered through a survey and was evaluated using percentages. In order to examine how students responded to trials I and II, below are their responses.

Table 4 summarizes the responses of students.

Table 4. Student Response

Trial to	Mark	Information
Trial I	90%	effective
Trial II	93%	effective

As shown in table 4 above, students' answers to the use of student worksheets based on the problem-based learning model showed a favorable response in terms of improving problem-solving skills during the teaching and learning process.

c. The average N-Gain value in Trials I and II, where this calculation employs the N-Gain formula and requires pretest and posttest data to observe the rise, indicates an improvement in problem-solving ability. The gain in ability had an average N-Gain of 0.39 in trial I while having an average N-Gain of 0.50 in trial II. The medium category's capacity for problem solving improved as a consequence of trials I and II.

Evaluation Stage

In trial I, the created problem-based learning model's student worksheets' practicality did not match the set practical standards. Due to the ineffective use of the created student worksheets throughout the three sessions, the observation of the application of learning to gauge practicality has not been satisfied. One of them is the failure to put learning into practice during the activities of creating and presenting the work as well as assessing and evaluating the approach taken to addressing problems.

In the social framework of implementing education, namely the development of a democratic environment and student collaboration in learning, as well as in the theory of management responses, including the activities of teachers tend not to position themselves as learning resources but give freedom to students to express opinions. Furthermore, because there were still indicators of effectiveness that had not been met, such as the posttest results of students' mathematical problem-solving abilities in trial I, which did not meet the achievement criteria, the effectiveness of learning in the form of student worksheets with the problem-based learning model that was developed did not meet all the established effective criteria. the standard completeness. So that revisions were made to lesson plans and student worksheets on the time allocation in the learning process. While in trial II the practicality and effectiveness of learning were all fulfilled so that no further trials were carried out.

Discussion

It will be known that the findings of the analysis of the data acquired reveal the following based on the data received from the study results:

The Validity of Student Worksheets Based on the Developed Problem Based Learning Model

The validity test was conducted to determine the shortcomings of the learning device's original draft by taking into account the problems in Class VIII MTs Preparation Negeri 4 Medan pertaining to fundamental skills, information, practice problems, and samples. The validation results of the five validators state that the learning tools include: With a few small adjustments, learning implementation plans and student worksheets are still valid and usable. The tests of mathematical problem-solving ability were likewise deemed legitimate by the five validators. So that the pretest and posttest problem solving ability tests were tested on students outside the trial class, so the problem solving ability tests were valid with very high reliability. Antari, et al.'s research from 2022 lends credence to this. If professional judgment demonstrates that the student worksheets are grounded on a solid theory and have internal consistency, the learning aids they represent are said to be legitimate, namely there is interrelationship between a component in the developed device. Consequently, it can be said that the student worksheets created have complied with the valid standart.

The Practicality of Student Worksheets Based on the Developed Problem Based Learning Model

The results of the evaluation of experts who claim that the created student worksheets are practicable to use with some adjustment and learning implementation may be observed from the student worksheets based on problem-based learning models that have satisfied practical requirements. The average observation score for the implementation of learning in trial I was 2.89 in the low category, which means that it does not meet the practical success criteria. The scores for each aspect of the observation of the implementation of learning using

the developed student worksheets were 2.80, 2.75, and 3.11. In contrast, in trial II, each component obtained ratings of 3.93, 3.92, and 4.17, resulting in an average rating of 4.01 in the high category, which indicates that the trial II implementation of the learning fulfilled the success requirements. According to research by Yusri, et al. (2021), student worksheets are a realistic example of a learning tool. This is because problem-based learning models are used in the educational process to improve problem-solving skills. Thus the student worksheets developed are practical for use by teachers and students.

The Effectiveness of Student Worksheets Based on the Developed Problem Based Learning Model

Three criteria are used to evaluate the effectiveness of student worksheets, namely:

1. classically the students' learning completeness, in trials I and trials II more attention was paid to problem-solving skills on the basis of comprehension of the issue to become a reference for improvement so that students did not think that understanding the problem was not necessary to write it down. So that the learning completeness of students in terms of problem-solving abilities is tested using tests in the form of essays. The findings of trial I indicated that they did not satisfy the standards for pupils who had completed all of their classical education, but the results of trial II indicated that they had. This is also corroborated by the findings of Ayuni's research, et al. (2020), which revealed that from trial I to trial II, students who employed the creation of student worksheets had more complete learning outcomes. According to the findings of this study, it seems that the created student worksheets can aid students in mastering classical learning.
2. student responses, In trial I and in trial II the students' responses were positive by showing that the learning was interesting, not boring and made it easier for students to understand the material presented. This is in line with Risfalidah's research (2019) where the research conducted found that students' responses to all aspects, It may be determined that students' responses to components and learning activities with model-based learning models problem-based learning are favorable, especially learning tools consisting of student worksheets and ability exams. Thus, it appears that the developed student worksheets contribute positively to student responses in learning.
3. an increase in problem-solving abilities, based on the N-Gain value, there was an increase in trials I and II. This is confirmed by study findings by Yusri, et al. (2021), which demonstrate that research conducted with the development of problem-based learning tools can improve problem-solving skills which consist of understanding problems, planning problems, solving problems and checking again.

C. CONCLUSIONS AND SUGGESTIONS

Based on the analysis results, findings, and discussion in the previous discussion, we get the following conclusions.

1. Student worksheets based on the problem-based learning model developed are declared valid
2. Student worksheets based on the problem based learning model developed were declared practical with expert assessments obtained that: a) student worksheets were used with slight revisions and observations, 2) results of observations of the implementation of learning by being in the high category or well implemented .
3. Student worksheets based on the problem-based learning model that was developed were declared effective in terms of: a) classical student mastery , b) positive student responses to learning aspects, c) increased problem-solving abilities based on pretest and posttest results with an average score The normalized N-Gain average in trial I and trial II are in the moderate category.

The result of this study suggest that future researchers should focus more on indicators of students' aptitude for solving mathematical problems, monitor students in small groups to foster productive discussion, and use student worksheets centered around problem based learning as an alternative for teachers to hone their skills with different material so that students will be more effective in the learning process and teachers will be better prepared.

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