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Development of Problem-Based Learning Teaching Materials to Improve Mathematical Problem Solving Ability and Self-Efficacy Students

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Abstrak

Penelitian ini bertujuan; Penelitian ini bertujuan untuk menganalisis: keabsahan bahan ajar pembelajaran berbasis masalah untuk meningkatkan kemampuan pemecahan masalah dan Self-Efficacy matematis siswa; kepraktisan bahan ajar tersebut; dan keefektifan proses pembelajaran dengan menggunakan TEAC. Menilai Self-Efficacy siswa setelah memanfaatkan bahan ajar. Penelitian ini merupakan penelitian pengembangan. Penelitian ini memiliki dua tahap yaitu merancang bahan ajar pembelajaran berbasis masalah dengan menggunakan paradigma pengembangan Four-D dan mengevaluasinya di kelas X IPS di salah satu SMAN di Kota Medan. Hasil penelitian menunjukkan bahwa: Profesional menganggap bahan ajar pembelajaran berbasis masalah valid, praktis, dan efektif. *Self-Efficacy* matematis siswa meningkat dari uji coba I ke uji coba II setelah memanfaatkan sumber belajar berbasis masalah.

Kata Kunci: Bahan ajar pembelajaran, Pembelajaran Berbasis Masalah, Model Pengembangan *Four-D,* Kemampuan pemecahan masalah matematis dan *Self-efficacy* siswa

Abstract

The aim of this study; This research aims to analyze: the validity of problem-based learning teaching materials to improve students' problem-solving abilities and mathematical Self-Efficacy; the practicality of the teaching materials; and the effectiveness of the learning process using TEAC. Assessing students' Self-Efficacy after using teaching materials. This research is development research. This research has two stages, namely designing problem-based learning teaching materials using the Four-D development paradigm and evaluating them in class X IPS at one of the high schools in Medan City. The research results show that: Professionals consider problem-based learning teaching materials to be valid, practical and effective. Students' mathematical self-efficacy increased from trial I to trial II after utilizing problem-based learning resources

***Keywords**: Learning teaching materials, Problem Based Learning, Four-D Development Model, Mathematical problem solving ability and Student self-efficacy.*

A. Introduction

The importance of problem solving was expressed by (Maulia, 2017) by stating that through problem solving, students can learn to deepen their understanding of mathematical concepts by working through selected issues using mathematical applications to real problems. The

development of mathematical problem-solving abilities can equip students to think logically, analytically, systematically, critically, and creatively. Students' problem-solving abilities can be seen from the stages of problem solving according to Charles (Rustam.E., Sidabutar.D.R., 2017), namely, (1) Understanding the Problem, (2) Planning the Problem Solving, and (3) Answering the Problem.

However, the reality is not as expected. The low problem-solving ability of students can be seen from the results of the initial mathematical problem-solving ability test. The researcher gave questions to measure the initial mathematical problem-solving ability with the indicator that students were able to solve problems in class X IPS 4 SMA Negeri 7 Medan on November 23, 2022, as many as 22 people. Questions were given to measure the initial mathematical problem-solving ability with the indicator that students were able to solve problems as follows:

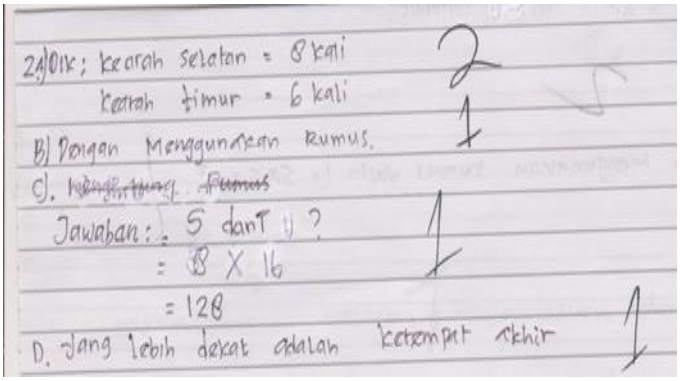

Figure 1. Student Answer I Problem Solving Ability

Based on the initial mathematical problem-solving ability test conducted, it can be seen that students are still unable to understand problems and solve problem-solving questions given to students according to the indicators of mathematical problem solving so that students' problem-solving abilities are still low. Students often have difficulty understanding questions and find it difficult to determine the formula used, even though mathematics is not material to be memorized but requires reasoning and problem solving (Ayu, D., & Dita, 2017).

The demands for developing self-efficacy are written in the mathematics curriculum, including stating that mathematics lessons must instill an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention, interest in mathematics lessons, as well as a persistent and confident attitude in solving problems. In other words, self-efficacy is one of the goals of mathematics subjects that must be achieved.

According to (Bandura, 1989) Self-efficacy in a person will result in: (1) influencing decision making and influencing the actions that will be taken; (2) helping how far he acts in an activity, how long he persists when he gets into trouble and how flexible he is in situations that are less favorable for him; (3) influencing thought patterns and emotional reactions.

(Masri, MF., 2018) also explains that measuring a person's self-efficacy refers to three dimensions, namely (1) level (level of difficulty of the problem), (2) strength (resilience), (3)

generality (breadth). Based on the results of the initial self-efficacy questionnaire conducted by researchers on students of SMA Negeri 7 Medan, it was found that their self-efficacy was still low. This is in accordance with the data obtained by researchers from administering a self-efficacy questionnaire in the form of a closed questionnaire scale containing several statement items with the answer choices Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS) to 27 students of class X IPS 4 SMA Negeri 7 Medan. it was found that many students still lack self-confidence to solve the problems given. Many students also do not want to try to complete the math assignments given and choose to give up.

This is in accordance with the results of the researcher's interview with one of the mathematics teachers at SMA Negeri 7 Medan who said that the teacher had not prepared learning models and teaching materials that were appropriate to student needs. The learning carried out still uses conventional learning. The teacher only explains the procedure with a few questions and answers, gives examples of questions and gives practice questions. This results in students not being accustomed to using their own knowledge in solving problems given to them.

To achieve learning goals, teachers must be able to design valid and effective teaching materials. There are several criteria in determining the quality of the results of developing teaching materials. According to (Nieveen, 2013) the criteria for a learning model are said to be good if the model includes: (1) validity, (2) practicality, and (3) effectiveness. Teaching materials are said to be valid if there is a consistent relationship between each component of the teaching materials developed with the characteristics of the applied learning model (Aisyah., 2016) , it is said to be practical if the device is easy and can be implemented, and it is said to be effective if the learning objectives can be achieved through the use of the developed teaching materials.

Problem-based learning according to (Nurzazili., Irma, A., Rahmi, 2018) is a learning environment where problems control the teaching and learning process. This means that before students learn, they are given bait in the form of problems. The implementation of the learning process by applying the Problem Based Learning model is expected to help students understand concepts or learning materials well, draw conclusions and find answers to existing questions. According to Ward and Stepien et al (Ngalimun., 2017) "Problem-based learning is a learning model that involves students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems". This is in line with the opinion of (Prihastyo., 2019) that "Problem-Based Learning is a learning strategy that focuses on students with various problems faced in their lives".

This is reinforced by the results of (Maulia, 2017), resulting in the following conclusions: that there is a significant difference in the average mathematical problem-solving ability between students who receive the problem-based learning model and students who receive the guided inquiry learning model. The group of students using the PBL model is higher than the group of students using guided inquiry.

Furthermore, the results of the research by (Saragih, S., & Habeahan, 2014) explain that the mathematical problem-solving ability of students who take part in learning with the Problem Based Learning (PBL) model is higher than that of students who take conventional learning and the students' responses are positive to the Problem Based Learning (PBL) model. Mareesh (2013) in his research stated that the problem-based learning model or problem-based learning is more effective for teaching mathematics.

The results of the research by (Yanty Putri Nasution, E., Emjasmin, A., Rusliah, 2021) with the research title Problem Based Learning Model, Guide Inquiry, and Mathematical Problem-Solving Ability concluded that there is a significant difference in the average mathematical problem-solving ability between students who receive the problem-based learning model and students who receive the guided inquiry learning model. The group of students using the PBL model is higher compared to the group of students using guided inquiry. Based on the explanation that has been described previously, regarding the characteristics and advantages and supported by data from previous studies that show that learning with the Problem Based Learning model can improve students' mathematical problem-solving abilities and Self-efficacy. This is what makes researchers feel the need and have conducted research entitled " Development of Problem-Based Learning Teaching Materials to Improve Mathematical Problem Solving Ability and Self-Efficacy Students.

B. Research Method

This type of research is Research and Development, using the Thiagarajan, Semmel and Semmel learning device development model, namely the 4-D model (define, design, develop, and disseminate) (Sugiyono, 2018). In this study, what was developed was problem-based learning materials and the necessary instruments. The learning materials that will be developed in this study include the Learning Implementation Plan ,Student Books , and Student Activity Sheets. In addition, research instruments were also developed consisting of Mathematical Problem Solving Ability Tests and student Self-Efficacy questionnaires.

This research was conducted at SMA Negeri 7 Medan Class X Even Semester of the 2023/2024 Academic Year on Trigonometry material. This research lasted for three meetings. The research was conducted in 2023. The subjects in this study were 22 students of SMA Negeri 7 Medan, Class X IPS. The objects in this study were Mathematics learning materials in the form of Lesson Implementation Plans, Student Books , Student Activity Sheets,Problem Solving Ability Tests and Student Self-efficacy Questionnaires.

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C. Result and Discussion

Description of the Define Stage

The initial analysis conducted by the researcher in this development research was to find the problems faced in learning mathematics in schools. At this stage, the researcher conducted observations at SMA Negeri 7 Medan as a target to obtain the information needed. The observation was carried out on February 3, 2023 at 09.45 in the teacher's room and class X IPS 4. was to determine the basic problems needed in the development of learning materials. showed that several weaknesses were found in the learning materials used by teachers which indirectly contributed to the low mathematical problem-solving abilities and student self-efficacy. In the , the learning model used by the teacher is still lecture-based and teacher-centered, and does not yet describe activities that activate students to learn mathematical problem-solving abilities. Furthermore, students only have teaching materials in the form of books provided by the government. Students do not have other reference books except for the textbooks provided in the library (which can only be borrowed during class hours) and the student books used by the teacher do not start with problems but start with concepts, so that students do not construct their own knowledge and do not find their own concepts. Then, the examples and questions in the student's book do not support the development of students' mathematical problem-solving skills and self-efficacy.

Description of the Design Stage (Design)

The results of the development of students' mathematical problem-solving ability tests are arranged based on indicators, then the grids for students' mathematical problem-solving ability tests are arranged. The tests developed are adjusted to the level of cognitive ability. The scoring of the test results uses an evaluation guide that contains the key and guidelines for scoring each question item. The mathematical problem-solving ability test is in the form of a description consisting of 3 designed questions and a questionnaire consisting of 25 questions.

Description of the Development Stage (Develop)

The results of the define and design stages produce an initial design of a learning material called draft I. After the problem-based learning material is designed in the form of draft I, a validity test is carried out against experts (expert review) and field trials. Expert validation is conducted to see the validity of learning, content and language that covers all the teaching materials developed. The teaching materials are in the form of Student Books, Problem-solving ability tests and student self-efficacy questionnaires. The results of expert validation are used as a basis for revising and improving the learning teaching materials. You can find the validation results in table 1 below.

Table 1. Validation Results

No	Aspect	Average	Category
1	Student Book	4,4	Valid
2	Learning Tool Plan	4,3	Valid
3	Student Worksheets	4,2	Valid
4	Problem solving skill	4,3	Valid
5	Self Efficacy	4,5	Valid

Table 1 shows that the Learning Tool Plan, Problem Solving, Self Efficacy, Student Worksheets have a total "valid" average of 4.5. The data in this study were analyzed using descriptive statistical analysis. According to Sheskin (2004), descriptive statistics as an analysis tool for the purpose of describing data without drawing conclusions and making predictions. Common procedures used in descriptive statistics are in the form of tables, graphs, diagrams and calculations on the size of the central and dispersion of data. The initial design mentioned above is described as follows:

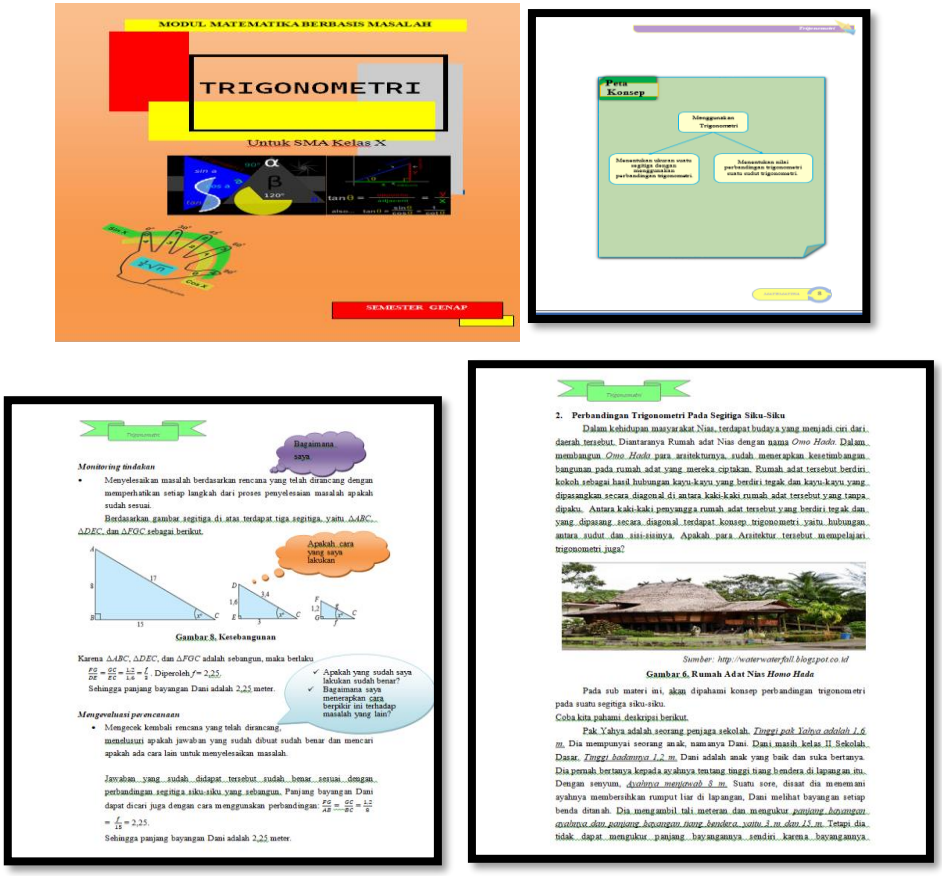

Figure 2. Development Product

Description of Effectiveness in Trial I

The mathematical communication ability test was conducted twice, namely before and after the implementation of learning activities after four meetings. The purpose of the post-test was

to determine the completeness of the mathematical problem-solving ability obtained by students after being given learning treatment using problem-based teaching materials on the material of two-variable linear equation systems. If categorized based on the level of student mastery, then the level of mastery of students' mathematical problem solving abilities in the pretest and posttest results of trial I can be seen in Table 2.:

Table 2. Level of Mastery of Mathematical Problem Solving Ability Results of Pretest and Posttest of Trial I

No	Value Interval	*Pretest*		*Posttest*		Category Value
		The number of students	Percentage	The number of students	Percentage	
1	86<SKPMM≤100	0	0%	4	14,81%	High
2	76<SKPMM≤85	9	37,03%	14	51,85%	Medium
3	56<SKPMM≤75	12	44,,44%	6	22,22%	Fair
4	0<SKPMM≤55	5	18,51%	3	11,11%	Low

From Table 2, it was obtained that in the pretest there were 5 students who obtained the low category (18.51%), 12 students in the sufficient category (44.44%), 10 students in the moderate category (37.03%), and no students had obtained the high category (0%). However, in the posttest, the results showed that 4 students obtained the low category (14.81%), 14 students in the sufficient category (51.85%), 6 students in the moderate category (22.22%), and 3 students (11.11%) obtained the high category.

Student Learning Completeness in Classical Student Self-efficacy

Description of the results of students' self-efficacy in trial I is shown in

Table 3 Level of Students' Self-efficacy Mastery Results of Pretest and Posttest of Trial I

Group	Statistics	*Self-efficacy*
High	N	5
	Average	86
	Standard Deviation	2,45
Medium	AND	15
	Average	76,33
	Standard Deviation	8,7
Low	N	7
	Average	56

	Standard Deviation	3,6
Overall	N	27
	Average	79,17
	Standard Deviation	10,13

Descriptively, it can be concluded that students' mathematical self-efficacy after using problem-based learning devices that have been developed based on categories (high, medium and low) resulted in students who had self-efficacy in the high group there were 3 people, in the medium group there were 30 students and in the low group there was 1 student. The average and standard deviation of students' mathematical self-efficacy abilities were 79.17 and 10.13 respectively.

Description of Effectiveness in Trial II

After conducting trial I on draft II, improvements were made to produce learning devices that meet all the effective criteria set. The results of the revision on draft II produced draft III which was then tested on 22 students of class X IPS 4 SMAN 7 Medan. Trial II was conducted to measure draft III as a problem-based learning material that meets all the effective criteria set. If categorized based on the level of student mastery, then the level of mastery of students' mathematical problem solving abilities in the pretest and posttest results of trial II can be seen in Table 4 below:

Table 4. Level of Mastery of Mathematical Problem Solving Ability
Results of Pretest and Posttest of Trial II

No	Value Interval	*Pretest*		*Posttest*		Category Value
		The number of students	Percentage	The number of students	Percentage	
1	85<SSE≤100	4	14,81%	7	25,93%	High
2	70<SSE≤85	14	51,85%	12	44,44%	Medium
3	55<SSE≤70	6	22,22%	8	18,51%	Fair
4	0<SSE≤55	3	25,92%	0	0%	Low

From Table 4 It was found that in the pretest there were 7 students who obtained the low category (25.92%), 6 students who obtained the sufficient category (22.22%), 14 students who obtained the moderate category (51.85%), and there were no students who obtained the high category (3 students) (14.81%). However, in the posttest, the results showed that 7 students (25.93%) obtained the high category, 12 students (44.44%) obtained the moderate category, 8 students (31.53%) obtained the sufficient category, and there were no students who obtained the low category (0%).

Student Learning Completeness in Classical Student Self-efficacy

Description of the results of student self-efficacy in trial II is shown in Table 5. If categorized based on the level of student mastery, then the level of mastery of students' mathematical problem solving abilities in the pretest and posttest results of trial II can be seen in Table 5 below.

Table 5. Level of Students' Self-efficacy Mastery
Pretest and Posttest Results of Trial II

Group	Statistics	*Self-efficacy*
High	N	13
	Average	58,71
	Standard Deviation	1,49
Medium	AND	12
	Average	39,29
	Standard Deviation	-
Low	N	2
	Average	1,67
	Standard Deviation	-
Overall	N	27
	Average	84,76
	Standard Deviation	10,27

Descriptively, it can be concluded that students' mathematical self-efficacy after using problem-based learning materials that have been developed based on categories (High, medium and low) resulted in students who had self-efficacy in the high group there were 13 people, in the medium group there were 12 students and in the low group there were 2 students. The average and standard deviation of students' mathematical self-efficacy abilities were 84.76 and 10.27 respectively.

Discussion

Based on the results of the posttest analysis of students' mathematical problem-solving abilities in trial I and trial II, it shows that students' mathematical problem-solving abilities have increased. The increase in students' mathematical problem-solving abilities can be seen from the average posttest results of students' mathematical problem-solving abilities obtained by students in trial I of 66.65% increasing to 85.18% in trial II. Thus, there was an increase in students' mathematical problem-solving abilities by 18.53%. This shows that the use of problem-based learning devices that were developed had an impact on increasing students' mathematical problem-solving abilities. The increase in students' mathematical problem-solving abilities was due to the problem-based learning process that was developed starting with a problem, so that students could use their previous experiences in understanding and solving

mathematical problems. The problem was designed so that the learning process was more meaningful, so that it could be understood that the problems given could be used as a starting point in developing students' mathematical problem-solving abilities. Furthermore, the discussion carried out by students was a bridge for mutual assistance between students in understanding the problem. This is in line with Ausubel's theory (Trianto., 2017) namely that meaningful learning is a process that links new information to relevant concepts contained in a person's cognitive structure. In learning, the learning process starts from a problem and the process of constructing information occurs. In other words, knowledge will be meaningful to students if the learning process involves problems or is implemented with a problem-based learning model.

In relation to this, according to (Bhat, 2018) states that "learning using scientific problem-based learning devices achieves individual and classical completion. According to (Fitriyani, Y., Supriantna, N., & Sari, 2021)the mathematics learning outcomes of students who use the problem-based learning model in their learning are better than the mathematics learning outcomes of students whose learning does not use the problem-based learning model.

Based on the results of the research and support from previous research above, it shows that problem-based learning is significantly better in improving students' mathematical problem-solving abilities. So it can be concluded that problem-based learning devices have a positive impact on improving mathematical problem-solving abilities.

D. Conclusion

Based on the outcomes of the analysis and debate in this research, various conclusions are put up as follows: The teaching materials developed with the problem-based model used are declared valid, reviewed from the validity results by five experts who stated that the teaching materials consisting of: (1) the average validation results of the Learning Implementation Plan of 3.58; (2) the average validation results of the Student Book (BS) of 4.03; (3) the average validation results of the Student Worksheet of 3.77; and (4) the average validation results of the Mathematical Problem Solving Ability Test and Student Self-Efficacy of 3.92, can be used with minor revisions and without revision, where the total average value is at a value of $3 \leq Va < 4$ so that the experts stated that the teaching materials are categorized as valid and can be used with minor revisions. The teaching materials designed based on the problem-based learning model fulfill the requirements of practicality, assessed from interviews with instructors and students, and also analysis of the outcomes of observations of the implementation of learning. The first average attained was 3.04 (moderate category) and had not satisfied the conditions for success. However, after making multiple adjustments, the average observation of the application of learning climbed to 4.10 (high category). So that the teaching materials generated based on the problem-based learning approach succeeded in achieving the requirements for practicality. The learning process using teaching materials developed based on the problem-

based learning model has met the criteria for effectiveness as reviewed from: (1) the achievement of student learning completeness was achieved in trial II of 84.26% (18 students) completed learning; (2) The achievement of learning objectives has been achieved for each item in question number 1, obtained at 83.17% for learning objectives 1 and 2, the achievement of learning objectives for question number 2 was obtained at 79.89% for learning objective 3, the achievement of learning objectives for question number 3 was obtained at 86.83% for learning objective 4. (3) Achievement of Self-Efficacy and (4) Student reactions to the learning process utilizing instructional materials generated based on problem-based learning models fulfill the criteria for being successful since they have a positive average value. The increase in mathematical problem solving ability after using the developed learning materials can be seen from the average value of the normalized gain index, the initial test of students' mathematical problem solving ability with the criteria "Low" with a score of 0.298 ($0.3 < g \leq 0.7$) and the final test of mathematical problem solving ability there was an increase in value with the criteria "Medium" with a score of 0.489 (0.3

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