Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.9, No.7, 2018

Developing Learning Materials Based on Problem-Based Learning to Improving Students Mathematical Problem Solving Ability and Self-Regulated Learning at MAN Hutagodang Labuhanbatu Selatan

Aswan Efendi E. Elvis Napitupulu Bornok Sinaga
State University of Medan (UNIMED), Jl. Willem Iskandar Psr. V, Medan 20221, Indonesia

Abstract
There were three objectives of this research, namely; (1) to describe the validity of learning devices based on problem-based learning model to improve the ability of mathematical problem solving and students' self-regulated learning; 2) to describe the practicality of learning devices based on problem-based learning model to improve the ability of mathematical problem solving and students' self-regulated learning; 3) to describe the effectiveness of learning devices based on problem-based learning model to improve the ability of mathematical problem solving and students' self-regulated learning; and 4) improvement of mathematical problem solving ability and self regulated learning of students taught through problem-based learning based device. This research is a development research. This research was conducted through two stages, the first stage, the development of learning devices based on problem-based learning using Four-D development model, and the second phase tested the of learning devices based on problem-based learning developed in the XI IPA-1 and XI IPA-2 MAN Hutagodang Labuhanbatu Selatan class. From the results of experiment I and experiment II obtained: 1) problem-based learning developed valid; 2) problem-based learning developed practically; 3) problem-based learning that are developed effectively, in terms of a) students' learning mastery in experiment I test of 71.43% and 92% in experiment II; b) the achievement of teachers' ability to manage the learning on experiment I of 2.83 (good enough) and experiment II of 3.37 (good); 4) improvement of students' mathematical problem solving ability increased from t experiment I with an average of 76.91 to 8.15 in experiment II; and 5) increased student self-regulated learning increased from experiment I with an average of 2.97 to 3.03 in experiment II.
Keywords: Development of Learning devices, Problem Based Learning, 4-D Development Model, Mathematical Problem Solving Ability and Students' Self-Regulated Learning

1. INTRODUCTION

Mathematics is a field of study by all students from elementary to high school and even college. There are many reasons for the need for students to mathematics because mathematics is the basis of science and technology. Herman Hudoyo (1988) says that mathematics functions underlying science and technology. Similarly, Sinaga (1999) say that: "Mathematics is essential knowledge as the basis for lifelong work in the age of globalization". Therefore, a certain degree of mastery of mathematics is required for all learners so that later in life it is possible to get a decent job because of the age of globalization, no work without math. "More than that, man can not be separated from mathematics because mathematics is a human activity" (Freudental, 1973).

In studying mathematics, students are expected to achieve the objectives of mathematics learning as formulated by the National Council of Teachers of Mathematics (2000) five standard mathematical learning process: Problem solving, reasoning and proof, communication, representations and connections. While the 5 standard content in the mathematical standards of numbers and operations, problem solving, geometry, measurement, opportunities and analysis.

One of the objectives of study the mathematics NCTM mentions on standard content and process standards is problem solving. Sinaga (1999: 10) say that "problem-solving ability is the ability or strategic competence shown by students in understanding, choosing approach and solving strategies and solving models to solve problems ". While Mullis (2000) suggests that "learning is more emphasis on reasoning activities and problem solving is closely related to the achievement of high student achievement". Even Posamentier and Stepelmen (1990) put problem solving as the first sequence of 12 essential mathematical components and learning to solve problems is a principal reason for studying mathematics. While PISA (Program for International Student Assessment) and Bloom's Taxonomy put on problem solving skills at High Order Thinking level which is at level 4 or C 4. PISA is an international study to test student literacy achievement of reading, math, and science.

Facts on the ground, students problem solving skills are still low. The 2007 TIMSS report states that the ability of Indonesian students in problem solving is only 25% compared to countries such as Singapore, Hong Kong, Taiwan, and Japan which are already above 75%. TIMSS is an international study to evaluate education centered at Lynch School of Education at Boston College USA. The facts in MAN Hutagodang about students 'mathematical problem solving skills are seen from the questions tested in class XI IPA and students' answers. Problem given is problem solving because in answer, the student will pass the problem-solving process mentioned by Campione, Brown, and Connell (1988) that is understanding to problem, representation to problem

which facilitate them handle it and problem solving

In addition to the importance of problem solving skills in mathematics, as well as attitudes that must be possessed by students because in the curriculum of 2013, learning objectives cover the development of the sphere of attitude, knowledge, and skills. One of the attitudes students must have is the independence of learning because it is closely related to problem solving. Zimmerman (1990: 14) argues that "student learning independence is a special academic achievement of learning that gives emphasis to be a guideline for learning how students choose, classify and create advantages in learning for themselves and control learning goals.

The importance of learning independence for students is conveyed by the results of Darr and Fisher's (2004) study which reported that "independent learning ability correlates highly with student learning success". Students with high success levels make higher goals, use more effort, survive longer when facing difficulties and will most likely use independent learning strategies (Bandura, 1997). The effort of most students in finding solutions is through self-regulatory activity, in this case students' independence learns how students analyze problems, monitor the completion process, and evaluate the results (De Corte, 1996).

One of the factors that can improve students' mathematical problem-solving skills and student learning independence is the use of innovative and student-centered learning models. However, the use of innovative and teacher-centered learning models has not yet been done in MAN Hutagodang. This is evident from interviews with math teachers at MAN Hutagodang. They say that teachers often use teacher-centered and teacher-centered learning models. Aside from the interview, the Lesson Plans (RPP) used by teachers also shows that teachers use teacher-centered and teacher-centered learning models. Therefore, the learning model used in this research is problem based learning (PBM). "Using a problem-based learning model will help students to develop thinking skills, problem-solving skills, and learn the roles of adults to become independent learners" (Arends, 2008).

To support the implementation of learning with problem-based learning model, learning tools are needed that facilitate the planning, implementation and evaluation of learning. Learning tool is a collection of learning resources that enable students and teachers to do learning activities. Learning tools consist of syllabus, Learning Implementation Plan (RPP), student book, teacher book, student activity sheet, and test of learning result. The importance of the use of learning tools by teachers is mentioned in Law No. 14 of 2005 on teachers and lecturers that "in carrying out professional duties, teachers are obliged to plan lessons, carry out quality learning processes, and assess and evaluate learning outcomes". It is also available in the 2013 curriculum that a teacher must be able to utilize the learning resources that have been provided, able to develop media or other learning resources.

Learning device used by teachers have not been directed to teaching high-order thinking (high order thinking) in this case the ability to solve mathematical problems and the independence of student learning, the need to develop learning tools that teaching mathematical problem-solving ability and student learning independence. In addition, the tools teachers use do not relate to one another and are never validated and tested before use. This is evident from the teacher's admission that they say "learning tools are made only to fulfill obligations when there is supervision from the leadership and that is made by others".

Based on the above conditions and expectations, in this study will be developed learning tools in the form of Learning Implementation Plan (RPP), Student Book (BS), Student Activity Sheet (SAS), Problem Solving Tests and self study independence questionnaire by submitting a study with the title "The development of learning tools based on problem-based learning to improve students' mathematical problem solving skills and learning independence.

2. Literature

2.1 Mathematical Problem Solving Abilities

The problem in mathematics or known with mathematical problems different from the problem in general. Ruseffendi (1991: 335) reveals "a problem in mathematics is a matter of which he himself can not solve it without resorting to a routine way or algorithm." The same thing also conveyed Hudojo (1988) that the problem is said to be a mathematical problem when a question or question there is no specific rule or law that can be used immediately to find the answer.

The types of problems in mathematics are grouped into four types (Hudojo: 1997) as follows:

1. The problem of transcation is a matter of daily life which to complete it needs to be translated from verbal form to mathematical form.
2. The problem of application is to provide opportunities for students to solve problems by using various skills and procedures of mathematics.
3. Process problems, usually for formulating steps to formulate specific patterns and strategies for solving problems.
4. The puzzle problem, often used for recreation and pleasure as a useful tool for affective purposes in mathematics learning.

From the above opinions, it is illustrated that the problem arises because of a gap between what is expected and reality, between what is possessed and what is needed, between what is known to be related to a particular

problem and what it wants to know. While the mathematical problem is a question or a mathematical question that can not be directly answered with a formula or a certain theorem, but must examine the question or question first with a mathematical procedure. Therefore, the gap to solve this mathematical problem must be overcome. The process of how to address this gap is called the process of solving the problem.

NCTM (2000) argues that problem solving is the process of applying previously acquired knowledge to new and different situations. While Shadiq (2008) mentions that: "problem solving is the process of applying the previously acquired knowledge into an unfamiliar new situation or process of thinking to determine what to do when we do not know what to do"

Another opinion, Polya (1973) defines problem solving is the attempt to find a way out of a difficulty, achieve a goal that is not immediately achievable. Problem solving is a psychological process that involves not only the application of the propositions or theorems being studied. Based on the above opinion, it can be concluded that the problem solving ability is the ability to solve problems by using all the knowledge and strategies in solving it.

2.2 Students' Self-Regulated Learning

Students' self-regulated learning is an aspect of attitude that is one of the learning objectives. With independent learning, it is expected to establish an independent attitude. Independent attitude is formed starting from self, parents and teachers are influenced by the environment so that the role of parents and teachers is needed for children's independence is formed. Pannen (2001) reveals the main characteristic of self-study is the development of students' ability to do the learning process that does not depend on the factors of teachers, friends, classes and others.

One is said to be self-regulated according to roger (1990: 93) if: (1) can work alone physically, (2) be self-conscious, (3) able to construct expressions or ideas understood by others, and (4) self- emotionally. While the self-regulated learning can be interpreted as an active learning that is driven by the intention or motive to master a competence to overcome a problem and can be built with the provision of knowledge or competencies that have been owned. According to Chamot (2000) states that Self Regulated Learning is a learning situation where learners have control over the learning process through knowledge and application of appropriate strategies, understanding of their tasks, strengthening decision-making and learning motivation. Frank (1998) self-regulated learning is the ability to self-monitor his understanding, to decide when he is ready to be tested, to choose a good information-processing strategy. While Schunk (2011: 1) defines it as a learning process that occurs because of the influence of thoughts, feelings, strategies, and self-oriented behavior toward the achievement of goals. From the opinion of the experts above, it can be concluded, the self-regulated learning is the ability of a person in learning by determining their own strategies and learning objectives.

While Goodman (1999: 42) states that the independence of learning includes three aspects, namely (1) Independent (independent) defined as self-directed behavior, do not expect direction of others, and even try and solve the problem itself without the help of others , (2) Autonomy (set the right to care for others) or also called the tendency to behave freely and original, and (3) Self-Regulated Learning is a behavior based on self-confidence.

Self-Regulated Learning has benefits to student achievement. According to Yamin (2002: 117) self-regulated learning has many benefits to the cognitive, affective, and psychomotor abilities of students are: (1) Fostering responsibility, (2) Improving skills, (3) Problem solving, (4) Making decisions, (5)) Creative thinking, (6) Critical thinking, (7) Strong confidence, (8) Becoming a teacher for yourself.

To improve students' self-regulated learning, the indicators of student Self-Regulated Learning in this study are: (1) learning initiatives, (2) diagnosing learning needs, (3) setting learning goals and objectives, (4) monitoring, managing and controlling learning progress, 5) viewing difficulties as a challenge, (6) utilizing and finding relevant sources, (7) selecting and implementing learning strategies, (8) evaluating learning processes and outcomes, and (9) self -concept or self-concept Sumarmo: 2004)

2.3 Problem Based Learning

Problem-based learning model has been known since the time of John Dewey and developed for the first time by Howard Barrows in the early 1970s. Problem-based learning is a learning approach that uses the problem as a starting point for learning. The problems that can be used as a means of learning are problems that meet the real-world context, which is familiar with the daily life of the students. Through these contextual problems the students rediscover the knowledge of essential concepts and ideas from the subject matter and build them into the cognitive structure.

Arends (2008: 56) said that the problem-based learning model is a learning model where students work on authentic issues with the intent to develop their own knowledge, develop inquiry and higher-order thinking, develop self-reliance and self-confidence. Nurhadi (2003: 109) said that "Problem Based Learning (PBL) is a learning model that uses real-world problems as a context to learn about critical thinking and problem-solving

skills, and acquire essential knowledge and concepts from subjects". University of Southern California (2001) that problem-based learning is an inquiry-based approach with students or students gaining experience as investigators and teachers functioning as thinking trainers.

From some opinions above, it can be concluded that problem-based learning is one model of learning, where students are faced with real contextual problems with daily life to gain knowledge so that it can solve the problem based on his knowledge.

3. RESEARCH METHOD

This research is a development research using 4-D development model Thiagarajan, Semmel, and Semmel [23] in 1974 consisting of 4 stages, define, design, develop, and disseminate.

3.1 Subjects and Research Objects

Subjects in this study are students of class XI-IPA^1 and XI-IPA^2 MAN Hutagodang Labuhanbatu Selatan academic year 2017/2018, while the object in this study is learning devices developed by using problem based learning on fractional material. Learning devices developed are Learning Implementation Plan, Teacher's Book, Student's Book, Student's Worksheet, Ability of problem solving test and questionnaire students' self-regulated learning. Development of learning devices using the Thiagarajan 4-D development model. However, the disseminate stages are not performed.

3.2 Instruments and Data Analysis Techniques

Instruments in this study using tests, questionnaires and observation sheets. For more details are presented in Table 1.

Table 1 Data Analysis Instruments and Techniques

Rated Aspect	Instruments	The Observed Data	Respondents
Validity of problem based learning tools	Validation Sheet	Learning Implementation Plan, Teacher's Book, Student's Book, Student's Worksheet, Ability of Mathematical Problem Solving, Self-Regulated Learning	Expert/Specialist
Practicality of problem based learning tools	Observation Sheet	Learning Devices Implementation	Observer
Effectiveness of problem based learning tools	Test	Ability of Mathematical Problem Solving Test	Student
	Observation Sheet	Teacher's Ability to Manage Learning	Observer
	Questionnaire	Student's response	Student

3.2.1 Validity of Learning Device Based on Problem Based Learning

Learning tools developed based on Problem Based Learning are validated by five expert. Criteria of learning tools based on Problem Based Learning are as follows:

Table 2 Level of Criteria Validity

Va or value of average total	Validity of Criteria
1 ≤ Va<2	Invalid
2 ≤ Va<3	Less Valid
3 ≤ Va<4	Valid Enough
4 ≤ Va< 5	Valid
Va = 5	Very Valid

Source:(Sinaga, 2007) [24]

Annotation: Va is the value of determining the level of prevalence and learning devices using Problem Based Learning.

Meanwhile, to calculate the validity and Ability of Mathematical Problem Solving test and self-regulated learning questionnaires used product moment correlation formula that is:

$$r_{xy} = \frac{n\sum XY = \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left\{n\sum X^2 - \left(\sum X\right)^2\right\}\left\{n\sum Y^2 - \left(\sum Y\right)^2\right\}}} \quad [1]$$

Annotation:

X: Score item rxy: test validity coefficient

Y: The total score n : many respondents who took the test

Determining the royality coefficient of a form test description used the alpha formula as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma_1^{\,2}}{\sigma_1^{\,2}}\right) \quad [2]$$

Annotation:
r11 : test reliability coefficient
n : number of test items
$\Sigma\sigma i2$: the number of variance scores per test item
$\sigma i2$: total variance

3.2.2 Practicality of Learning Device Based on Problem Based Learning

The first of Analysis the practicality Problem Based Learning is to use the validation sheet, where all experts stated that the Problem Based Learning device can be used with "minor revision" or "no revision". As for seeing the enforce ability of the device used Problem Based Learning observation sheet improvement learning device. Criteria improvement learning device is as follows:
Very Low, If $0 \leq P < 1$
Low, If $1 \leq P < 2$
Enough, If $2 \leq P < 3$
High, If $3 \leq P < 4$
Very High, If $4 \leq P \leq 5$
Annotation:
P is the average score
Problem Based Learning device is said to be practical or easy to implement if the enforce ability of the Problem Based Learning are in the category of high minimal.

3.2.3 Effectiveness of Learning Devices Based on Problem Based Learning

Complete Classical Ability of Mathematical Problem Solving. The effectiveness of Problem Based Learning is based on student achievement in classical mastery learning. The criteria that states that students have been able to represent mathematically if there are 75% of students who follow the ability mathematical problem solving with a minimum value of 75. Percentage can be calculated by the formula:

$$Persentage\ of\ \ Agreement = \frac{Agrements\,(A)}{Disagreemnet\ \ (D) + Agreements\,(A)}\, x100\% \quad [3]$$

3.2.4 Teacher's Ability to Manage Learning

The activity of the teacher to manage the learning process is the ability to develop a familiar and positive learning atmosphere. The activity of determining the average score of the total aspects of the assessment of teachers' ability to manage learning adapts the steps Hobri developed by Suryaningsih [27] in 2014, with the following criteria: Criteria: Since the range of these scores is 0 to 5, the length of the interval within this score range is 5. To make the criteria of the effectiveness of the teacher's ability to manage the learning, this interval is subdivided into 5 sub equal intervals:
Very low, if $0 \leq P < 1$
Low, if $1 \leq P < 2$
Simply, if $2 \leq P < 3$
High, if $3 \leq P < 4$
Very High, if $4 \leq P \leq 5$

3.2.5 Student Response

Questionnaire responses of students were analyzed by calculating the percentage of many students who responded positively to each of the categories asked in the questionnaire by using the following formula:

$$PRS = \frac{\sum A}{\sum B}\, x100\% \quad [4]$$

Information :
PRS: Percentage of many students who respond positively to each of the categories asked
ΣA: Proportion of students who choose
ΣB: Number of students (respondents)
The criteria are set to say that students have a positive response to learning tools developed when the number of students who responded positively was greater than or equal to 80% of the many subjects studied for each trial by Sinaga [29] in 2007.

3.2.6 Improved The Ability to Mathematical Problem Solving

To calculate the improvement of students' mathematical understanding ability after using mathematical learning devices developed based on realistic approach integrated with Problem Based Learning determined by gain formula, that is:

$$gain = \frac{posttest\ value - pretest\ value}{ideal\ value - pretest\ value} \quad [5]$$

With the following criteria:

Table 3 Gain value Category

Gain Value	Category
gain < 3.0	Low
3.0 < gain < 7.0	Middle
gain > 7.0	High

Improvement of Students' Self-Regulated Learning To find out the scale of student's self regulated learning based on scores obtained students can use criteria that refer to the opinion of Prastini & Retnowati [31] in 2014 as follows:

Table 4 Level of Mastery of Student Learning Independence

No	Conversion Value		Category
	Value	Alphabet	
1	76-100	A	Very Good
2	51-75	B	Good
3	26-50	C	Enough
4	0-25	D	Not good

4. RESULT AND DISCUSSION OF RESEARCH

After conducting the research, there are some findings found, namely; the validity, the practicality, and the effectiveness of teaching materials, improving students 'mathematical problem solving ability, and improving students' self regulated learning.

4.1 Material Validity Of Teaching Materials

The validity of instructional materials is measured by the experts. Based on the results of expert materials analysis, learning devices based on problem based learning for both teachers' and students' books obtained the average value of total validity as shown in Table 2.

Table 2. The Validation of RPP, SAS, Teacher's and Student's Books

Aspects	Aspect Average(A_i)				Total (V_0)				Validity Degree
	RPP	SAS	Teacher's Book	Student's Book	RPP	SAS	Teacher's Book	Student's Book	
Template	4.65	4.51	4.34	4.31	4.45	4.34	4.30	4.21	**Valid**
Language	4.37	4.37	4.16	4.13					
Illustration			4.20	4.26					
Content	4.30	4.14	4.42	4.34					

Based on Table 2 above, the average value of the total validity of learning devices based on problem based learning is at intervals: $4 \leq Va < 5$. It means that the development of learning devices based on problem based learning is valid..

4.2 Practicality Of Instructional Materials

The practicality of teaching materials based on development of learning devices based on problem based learning seen in 2 (two) aspects, namely: (1) expert / practical assessment of the developed teaching materials can be used with minor revision; (2) the results of observation of the implementation of teaching materials in the classroom is quite high category (teaching material is applicable). Based on the result of observation data analysis of learning devices based on problem based learning, the average value of observation of teaching materials implementation for each meeting in experiment I shown in Table 3.

Table 3. The Average of Observation of the Implementation of Material in Experiment I

The Average of All Experts	Meeting $\overline{P_2}$		Total $\overline{P_3}$	Note
	1	2		
EXPERIMENT 1	3.39	3.34	3.37	High (Practical)

Based on Table 3, the average of observers of teaching learning device is in the high category ($3 \leq P \leq 4$) with the interval: $4 \leq Va < 5$. Based on the criteria of implementation, it means that the development of learning devices based on problem based learning developed is categorized as practical.

4.3 The Effectiveness Of Instructional Materials

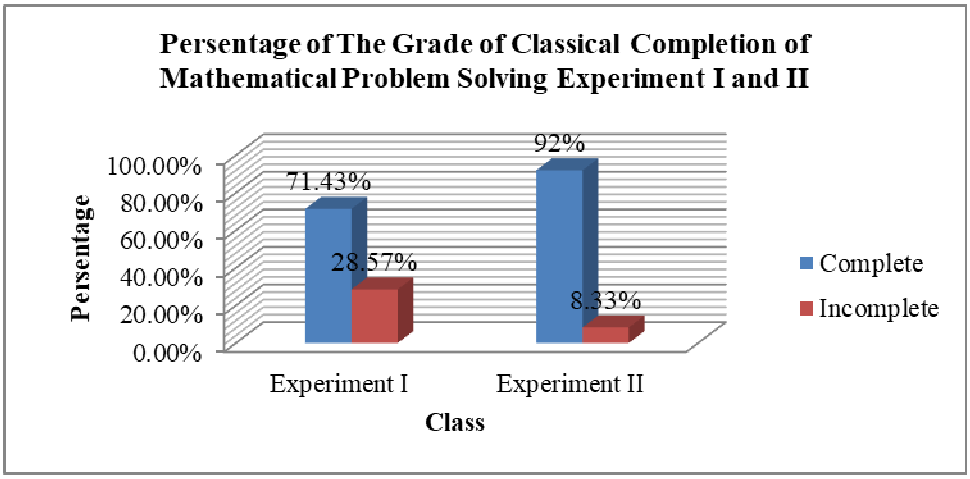
The criteria for determining the effectiveness of learning devices based on problem based learning in Experiment I and II consisted of three indicators as discusses as follows:

4.3.1 Completeness

Based on the finding of research in experiment I and II, the results obtained the completion as in Table 4:

Table 4.The Grade of Classical Completion of Mathematical Reasoning Ability in Experiment I and

Categories	Mathematical Problem Solving Ability			
	The total of students		Percentage	
	Experiment I	Experiment II	Experiment I	Experiment II
Complete	15	22	71.43%	92%
Incomplete	6	2	28.57%	8.33%
Total	21	24	100%	100%



Picture 1: Persentage of The Grade Classical Complete of Students' Mathematical Problem Solving

Based on Table 4 and picture 1, it is showed that posttest result of mathematical problem solving ability in Experiment I test did not met the criteria of classical completeness achievement. In accordance with the students' learning completeness criteria in classical is at least 85% of students who follow the learning achieving ≥71. Thus, the posttest result of mathematical problem solving ability in experiment II completely met the criteria of classical achievement. This is supported by Wulandari's (2018) study which concludes "Results of students' mathematical problem solving abilities through tests in the application of problem-based learning increases". This means that students' mathematics learning outcomes through tests in the application of problem based learning increases. Furthermore, Suci's research (2017) which also concludes the mathematical problem-solving ability of students with Better Problem Based Learning is better than STAD type learning model.

4.3.2 Students' activity

Student activity's in learning is effective, if four of the six criteria for tolerance of achievement of the ideal time used in categories 1, 2, 3, 4, 5 and 6 are met. The tolerance criteria for 3 and 4 must be met. Based on the results of research in experiment I and experiment II, the results obtained from student activities are as follows:

Table 5. The Percentage of Analysis Results of Student Activity in Experiment I and II

Meetings	The Percentage of Students' Activity (%)					
	1	2	3	4	5	6
Experiment I	26.56	15.1	17.19	27.6	10.42	3.13
Experiment II	27.08	14.58	18.75	26.04	8.33	5.21
Experiment III	27.6	10.94	20.83	26.56	8.85	0.52
% Average	27.08	13.54	18.92	26.73	9.20	2.95

Based on the data in Table 5, it can be showed that the result of the percentage of student's activity in the experiment I and experiment II did not meet the standard. While, percentage of student activity for each indicator in experiment III successfully met the standard of students' activity.

4.3.3 Students' Feedback

Students' feedback criteria can be effective, if there are 80% research subjects showed positive feedback against component of developing teaching material. Based on the results of research on experiment I and II, students give positive feedback to the content of teaching materials developed. This is reinforced by Mawaddah's research (2015: 10) found that students show positive feedback for learning mathematics model with discovery learning and problem based learning.

4.4 Improvement Of Mathematical Problem Solving Ability

To know the improvement of mathematical problem based learning, the data obtained from experiment I and trial II were analyzed by comparing the mean score of students. The description of improving students' mathematical problem solving using learning devices based on problem based learning developed in experiment I and II shown visually in Table 6.

Table 6. Description of the Results of Mathematical Problem Solving Ability

Description	Experiment I	Experiment II
Highest Score	97	97
Lowest Score	63	67
Average	76.91	82.15

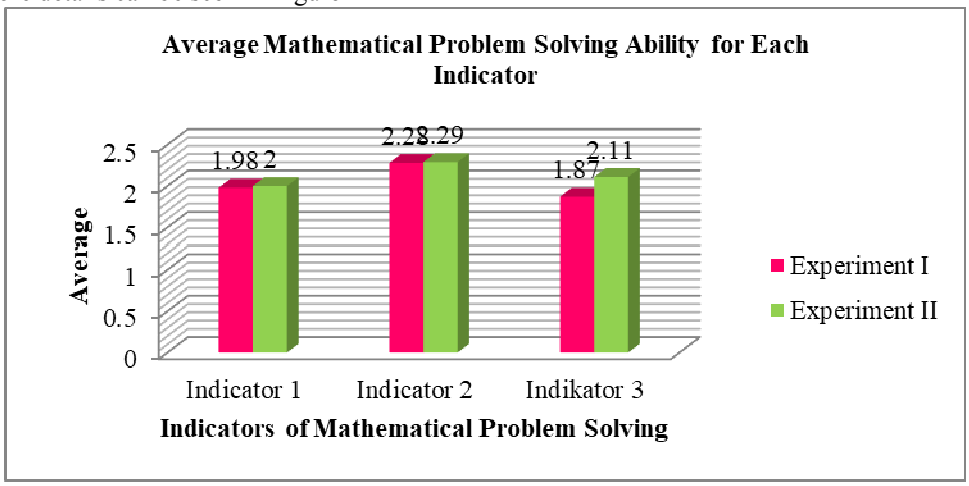
Based on Table 6, the results of the improvement of students mathematical problem solving ability on experiment I and experiment II indicate that the average of students' mathematical problem solving ability on the result of posttest experiment I was 76.91 increased to 82.15 in experiment II.

Furthermore, a description of the enhancement of students' mathematical problem solving ability by using learning devices based on problem based learning on experiment I and II for each student's mathematical problem solving indicator can be shown in Table 7

Table 7. The Average of Student Mathematical Problem Solving Ability for each indicator

Indicators	Mean for each indicator		
	Experiment I	Experiment II	Mean
Understand the problem	1.98	2	0.01
Plan for problem solving	2.28	2.29	0.01
Solve problems and evaluate	1.87	2.11	0.24

For more details can be seen in Figure 2



Picture 2: Average Mathematical Problem Solving Ability for Each Indicator

Based on Table 7 and Ficture 2. above, it can be concluded that students' mathematical problem solving

ability from experiment I to eksperiment II is seen from the average value of total and the average value of each indicator has increased through the application of learning devices based on problem-based learning developed. Increase in the average value of each of the highest indicators in indicator 3 because it is still resolving the problem while the indicators 1 and 2 slightly increased due to already been analyzed.

Then, Wijaya (2012: 32) The context in problem based learning is aimed at building or rediscovering a mathematical problem solving through the process of mathematical. The stages of problem solving is a part must be experienced by students in the process of developing mathematical communication in writing and also in the learning process with problem based learning.

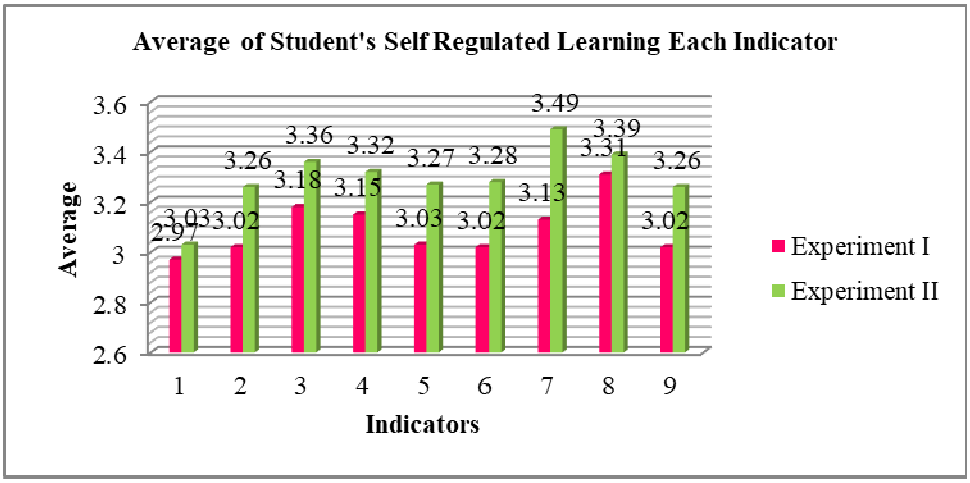
4.5 Improvement Students' Self Regulated Learning

Based on the results of experiment I and II, it is obtained the result of questionnaire of students' self regulated learning. This questionnaire is given at the end of each meeting which aims to see students' self regulated learning. Then obtained data from the results of questionnaire self regulated learning experiment I and II were analyzed to determine the improvement of students' self regulated learning by comparing the average score of students obtained from the questionnaire attitudes self regulated learning experiment I and II. The descriptions of improvement of students' self regulated learning after the application of developing problem based learning based material are shown in Table 8.

Table 8. The Mean of Self Regulated Learning Students'

No	Indikators	Mean for each indicator		Mean
		Experiment I	Experiment II	
1	Students demonstrate initiative in learning mathematics	2.97	3.03	0.06
2	Students organize and control their learning	3.02	3.26	0.24
3	Students organize and control cognition, motivation, and behavior in learning math	3.18	3.36	0.18
4	Students choose and apply learning strategies	3.15	3.32	0.17
5	Students evaluate the learning process and outcomes	3.03	3.27	0.24
6	Students can view difficulty as a challenge	3.02	3.28	0.26
7	Students seek and utilize relevant learning resources	3.13	3.49	0.36
8	Students are sure about themselves	3.31	3.39	0.08
9	Students demonstrate initiative in learning Students demonstrate initiative in learning mathematics	3.02	3.26	0.24
The mean of each indicator		3.09	3.29	
The mean of emotional intelligence improvement from experiment I and II				0.20

For more details can be seen in Ficture 3



Ficture 3. Average of Student's Self Regulated Learning For Each Indicator

Based on Table 8 and Figure 3 above can be seen that the average score of the highest indicator is in the indicator 7 that is Students search and utilize the relevant learning resources and the lowest is indicator 1 that is Students show initiative in learning mathematics. Then the level of mastery of student learning independence is seen from the increase of experiment I to experiment II, so it can be concluded that the average of the results of questionnaire student self-reliance increased from the results of experiment I to experiment II, namely the experiment I of 3.09 while on the test experiment II of 3.29 and increase by 0.20. While the average score of each indicator also there is an increase from experiment I to experiment II. Each average score of each indicator

on experiment I increases to experiment II

5. CONCLUSION

Based on discussion of the research, the conclusions are drawn as follows:

1. The learning devices developed has met the valid category with the average total validity of RPP of 4.45, the average student book validity of 4.30, and the average validity of SAS of 4.34.
2. The learning devices developed have met the practical criteria reviewed from the expert's assessment of learning tools developed with minor revisions and without revisions, as well as interviews with some students saying that learning tools developed are easy to use.
3. The learning devices developed have met the effective criteria. Effective criteria are reviewed from the criteria of achievement of students 'learning mastery and the achievement of teachers' ability to manage learning.
   a. Achievement of students' complete mastery in experiment I have 15 students complete (71.43%) of 21 students, whereas in experiment II there are 22 students complete (92%) of 24 students, so this criterion has been achieved.
   b. Achievement of teachers' ability to manage learning in experiment I, the average of teacher ability to manage learning is 2.83 (good enough), while in trial II average is 3.37 (good), so this criterion has been reached.
4. Improved mathematical problem solving ability using problem-based learning tools seen from the average achievement of students' mathematical problem solving abilities in experiment I of 76.91 increased to 82.15 in experiment II.
5. Students' self-regulated learning increased from experiment I to experiment II using learning based on problem-based learning.

REFERENCES

Arends, I.R. 2008. *Learning to Teach, Belajar untuk Mengajar. Edisi Ketujuh. Jilid Dua*. Terjemahan oleh Soedjipto, Helly, P. dan Soedjipto, Sri, M. Yogyakarta: Pustaka Pelajar

Arikunto. S. 2009. *Dasar-Dasar Evaluasi Pendidian (edisi revisi)*, Jakarta: Bumi Aksara

Aulia, Y. 2016. *Pengembangan Perangkat Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa Smp Taman Siswa Tanjung Sari Medan*. Tesis tidak diterbitkan. Medan: Program Pasca Sarjana UNIMED

Bandura, A. 1997. *Self Efficacy: The Exercise Of Control*. New York: W.H. Ferman & Company

Branca, N. A., 1980, '*Problem Solving as a Goal, Process, and Basic Skills', in S. Krulik and R. E. Reys (eds.*), *Problem Solving in School Mathematics*, (pp. 3-8) National Council of Teachers of Mathematics: Virginia.

Cai, J. Kaiser, G. Perry, B. Ying, WN (Eds.). 2009. *Effective mathematics teaching from teachers' perspectives* : National and cross-national studies. Rotterdam: Sense Publisher.

Campione, J.C.; Brown, A.L, and Connell, M.L. 1988. Metacognition: On the Importance of Understanding What You Are Doing. In Charles, R.I. and Silver, E.A. (Eds). *The Teaching and Assessing Of Mathematical Problem Solving,* Vol, 3. Reston , VA: NCTM.

Chamot, A.U, Barnhardt, S, Eldinary P.B & Robbins, J. 2000. *The Learning Strategies Handbook.* New York, ISSN: 1550-6908

Department of Education (1996). *Educator Servis teaching & Learning Curriculum Resources, Mathematics Curriculum Framework Achieving Mathematical Power Januari 1996*.

De Corte, E. Verschaffel, L. Van Coillie, V. 1998. *Influence of number size, problem structure and reesponse mode on children's solution of multiplication word problems* (hlm. 197-216). Journal of Mathematical Behavior

Dick, W., Carey, L.,dan Carey, J.O. (2009). *The Systematic Design of Instruction*. New Jersey : Pearson

Freudenthal, H. 1973. *Mathematics as an Educational Task*. Dordrecht: Reidel Pub. Co

Goodman & Smart. 1999. *Emotional Intelligence.* New York: Bantam Boks

Hudoyo, H. 1998. *Pembelajaran Matematika Menurut Kontrutivisme*. Malang : PPs. IKIP Malang

_____2003. *Pengembangan Kurikulum dan Pembelajaran Matematika.* (Common Text Book) Malang : FMIPA Universitas Malang/ IMSTEP

_____2005. *Pengembangan Kurikulum dan Pembelajaran Matematika*. Bandung: Jurusan Pendidikan Matematika Fakultas Matematika dan ilmu Pengetahuan Alam Universitas Negeri Malang

Ibrahim, M dan Nur, M. 2000. *Pengajaran Berdasarkan Masalah*. Surabaya: Unesa-University Press

Mullis, et,al. 2000. Timms 1999. *Internastional report.* Boston: the international study center, boston college, lynch school of education

NCTM. 2000. *Handbook of research on mathematics teaching and learrning*, editor: Douglas A. Grows USA: Macmilan Library Reference

Pannen, P. 2001. *Konstrutivisme Dalam Pembelajaran.* Jakarta : PAU-PPAI Universitas Terbuka

Plomp, T. 1997. *Educational and Training System Design*. Nederlands: University of Twente Faculty of Educational Science and Technology

Polya, G. 1973. *How to Solve (2nd Ed)*. Princeton University Press

Posamentier, A.S dan Stepelman, J. 1990. *Teaching Secondary School Mathematics,* Tecniques and Enrichment Units, 3th edition. Ohio: Merrill Publishing Company Columbus.

Roger, R. 1990. *The 19 Habits of Highky Successful People: Powerful Strategis for personal Triumph. Malaysia:* Wynwood

Russefendi, E.T. 1991. *Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika untuk Meningkatkan CBSA*. Bandung: Tarsito

Shadiq, F. 2008. *Pentingnya Pemecahan Masalah*

Shunck, D.H, & B.J Zimmerman. 2011. *Handbook of Self-Regulated of Learning and Performance.*Routledge. NewYork and London

Sinaga, B. 1999. *Efektivitas Pembelajaran Berdasarkan Masalah (Problem Based Instruction) pada Kelas I SMU dengan Bahan Kajian Fungsi Kuadrat*. Jurnal Penelitian Bidang Pendidikan

_____. 2007. *Pengembangan Model pembelajaran matematika Berdasarkan Masalah Berbasis Budaya Batak (PBMB3).* Disertasi Tidak dipublikasikan. Surabaya: PPs Universitas Negeri Surabaya.

Sumarmo, U. (2004). *Kemandirian Belajar : Apa, Mengapa, dan Bagaimana Dikembangkan pada Peserta Didik*. Makalah disajikan pada Seminar Nasional Pendidikan Matematika di UNY

Suci, T. 2017. Differences in Mathematical Problem Solving Ability and Self-Efficacy Students Taught Using Problem Based Learning and Learning Type STAD. *IOSR Journal of Research & Method in Education* (online) Volume 7, Issue 6 Ver IV (Nov-Des.2017), PP56-65

Susanto, J. 2012. *Pengembangan Perangkat Pembelajaran Berbasis Lesson Study dengan Kooperatif Tipe Number Heads Together Untuk Meningkatkan Aktivitas dan Hasil Belajar IPA di SD*. Journal Of Primary Education : 1 (2)

Thiagarajan, S. Semmel, D.S. Semmel, M. 1974. *Instructional Development for Training Teachers of Exceptional Children*. A Sourse Book. Blomington: Central for Innovation on Teaching The Handicapped

Trianto, 2011. *Mendesain Model Pembelajaran Inovatif-Progresif: Konsep, Landasan dan Implementasinya pada Kurikulum Tingkat Satuan Pendidikan (KTSP)*. Jakarta: Kencana.

Undang-undang Nomor 14 Tahun 2005 *Tentang Guru Dan Dosen.* Jakarta: Presiden Republik Indonesia

University of Southrn California. 2001. *Problem Based learning*

Wijaya, A. 2012. *Pendidikan Matematika Realistik: Suatu Alternatif Pendekatan Pembelajaran Matematika*. Yogyakarta: Graha Ilmu.

Yamin,M. 2013. *Strategi dan metode dalam model Pembelajaran*. Jakarta: GP Press Group.

Zimmerman, B. J. 1989. *A Social Cognitive View Of Self-Regulated Academic Learning* (hlm. 329-339). Journal Of Educational. Psycology. Vol. 81,3.