Development of Autograph-Assisted Problem-Based Learning Tools to Improve Students' Mathematical Problem-Solving Ability

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Abstract
This study aims to: (1) describe the validity, practicality and effectiveness of problem-based learning tools assisted by Autograph to improve students' problem solving abilities; (2) Describe the improvement of students' mathematical problem solving skills with the help of Autograph by using the developed learning tools. This research is a development research that is used to produce certain products and test the effectiveness of these products. To develop and validate the product, it is combined using the Thiagarajan 4D development model, which consists of four stages of development, namely: define, design, develop, and disseminate. The results showed that: (1) Learning tools based on the Autograph-assisted Problem Based Learning model included valid, practical and effective categories; (2) The problem solving ability of students using problem-based learning tools that were developed increased in terms of the average achievement of students' problem solving abilities, namely in the first experiment of 66.67%, increasing in the second experiment of 86.67%. The increase is also seen from the average N-Gain score of 2.50 which is in the high category.
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1. Introduction

To realize a more meaningful mathematics learning so that student achievement is high, teachers must be creative and innovative in developing learning activities during the teaching and learning process. Pentury (2017:2) states that "teaching is no longer an effort to convey knowledge, but rather an effort to create an environmental system that teaches students so that teaching goals can be achieved optimally".

Learning activities are designed in such a way as to provide a learning experience that involves mental and physical processes through interactions between students, students and teachers, the environment and other learning resources in order to achieve learning objectives. These aspects are included in a term called a learning model, as stated by Joyce and Weil (1996:13-16) stating that "a learning model can be analyzed according to the four core operational concepts of the model that characterize, namely: (1) syntax, (2) social systems, (3) reaction principles, (4) support systems, (5) goals, and (6) instructional and support impacts".

The success of students in learning cannot be separated from the implementation of the learning model in the teaching and learning process of mathematics. Therefore, the selection of methods, strategies, and approaches in designing learning models in order to achieve active and meaningful learning is a demand that must be met by teachers. Rahmawati (2014) states "the implementation of the learning process will not be achieved properly if it is not well planned, regulated, and the teacher looks for the right way in its implementation". Widayati and Hafis (2012:17) say that, "the quality and success of learning is strongly influenced by the ability and accuracy of teachers in choosing and using learning models".

The learning model is considered important because it can motivate students towards mathematics, the delivery of mathematics material can be fun, easy to understand, not scary, and it is shown that mathematics has many uses. Nani, Hamid, and Bahara (2018:49) argue that "the learning model is selected and adapted to the environment related to real life, starting with informal ways through modeling before the formal way". The learning model is needed because it will have a positive impact on the ability and activity of students in learning (in Ainin, Mulyono, and Syahputra, 2020: 2). Similarly, Rahmawati and Suryanto, (2014: 89) argue that "the learning model is one component that can affect the achievement of learning objectives".

The teaching and learning process is a very complex form of problem, because it involves many interrelated elements so that its success is also determined by these elements, especially the teacher as the process of controlling the pace of the learning process. According to Sudjana (1989:29) "the learning process is the process of changing students' behavior from the various experiences they get". So in this activity will involve various components that interact with each other to achieve the expected goals. To realize a more meaningful mathematics learning process so that student achievement is high, teachers must be creative and innovative in developing learning activities during the teaching and learning process.

But in reality, in the learning process in the classroom, students feel bored and less challenged to the lesson because the learning process only provides routine problems that can be solved by simple analysis and mechanistic solutions. Almost all mathematics learning processes begin with giving understanding, formulas, examples, and end with exercises. Occasionally found proof of mathematical problems that are solved using pictures or simple sketches (in Syahputra and Surya, 2015:126). Perwitosari, Asnawati, and Bharata (2018: 537) explained that "in the process of learning mathematics, teachers still use conventional learning models so that students are less actively involved in learning". In addition to learning that is less effective, they only record the answers to the questions that have been discussed without knowing the meaning.

This also happened at SMAS Mentari Bangsa. Based on the results of observations, information was obtained that the learning process carried out did not refer to effective learning. Most of the time during the learning process in the classroom, students are only given problems that can be solved with very simple solutions. On average, all mathematics learning processes are only given an explanation of the understanding, formulas, examples, and questions contained in the student textbooks. Then students are only given assignments to do at home. Teaching and learning that is carried out also tends to be teacher-centered, the teacher acts more actively as a giver of information and students only actively receive information by listening, taking notes or copying, and memorizing, thus making the knowledge gained quickly forgotten and meaningless. This kind of learning process makes it difficult for students to achieve optimal learning outcomes.

The learning process has not fully taught students optimally and tends to only present monotonous direct learning to students. Halim (2017:6) states "teachers only explain lessons and students only listen to learning". This of course causes students to be less active in learning and student responses to learning are also very low because the approach applied by the teacher is less attractive and students play a passive role in learning. This causes students to become easily bored in carrying out the learning process because the learning carried out tends to be conventional.

From the observations at SMAS Mentari Bangsa, the textbooks used in the learning process are textbooks published by Erlangga. Although the book has been compiled based on Core Competencies and Basic Competencies in accordance with the 2013 Curriculum, the book is not yet based on the PBM model. In accordance with the problems stated earlier, students have problems in problem solving abilities. To overcome this, the PBM model was chosen because it is suitable to overcome these problems, so the learning tools used must be based on the PBM model. The questions in the book are also not fully questions that can measure students' mathematical problem solving abilities. In addition, the questions in the book are still general in nature. For this reason, it is necessary to develop a book that is expected to be able to overcome the problem of students' low mathematical problem solving abilities.

In addition to textbooks, other tools are also needed that help students understand the material provided, namely the Student Activity Sheet (LKPD). Putra, Herman, and Sumarmo (2017:8) said, "with the LKPD, students can improve their problem-solving skills and students' attitudes towards mathematics". However, the reality that happened at SMAS Mentari Bangsa Medan was that there were no teachers in designing and using LKPD in the learning process. The teacher only uses the questions that are in the school textbook that students do in the exercise book. For this reason, it is necessary to develop LKPD which will be used in teaching and learning mathematics in the classroom. Thus, valid, practical, and effective learning tools will be developed to improve students' problem solving abilities.

One of the learning models that can be developed is a problem-based learning model. Delisle (1997:6) argues that "problem-based learning is a structured learning model that can help students to build knowledge and problem-solving skills and help students to master important knowledge". In practice, problem-based learning makes problems as the beginning of the learning process. The problems presented in problem-based learning are contextual problems and are close to students' daily lives.

This is supported by several research results, Sumartini (2016:157) states that "the increase in mathematical problem solving abilities of students who receive problem-based learning is better than students who receive conventional learning". Furthermore, the results of Octaria and Eka's research (2017: 53) suggest that "the increase in mathematical problem solving abilities of students who receive PBL learning is better than students who receive conventional learning in terms of overall and KAM (high, medium, and low)".

However, the fact is that in the field students' problem solving abilities are not as expected because they are still in the low category. This can be seen from the results of the Trend in International Mathematics and Science Study (TIMSS) a study conducted by the International Association for the Evaluation of Educational Achievement (IEA), in 2007 placing Indonesia in 36th place out of 49 participating countries with an average score of student score is 397, while the international average score is 500 (Mullis, et al., 2008).

Another factor that is thought to affect students' problem solving abilities is the use of ICT-based learning media which will provide a lot of convenience for students in solving math problems. The use of ICT is one of the six principles of school mathematics (NCTM, 2000) stating "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning".

One of the computer software that can be used to assist teachers in carrying out mathematics learning is Autograph Software. According to Karnasih (2008:5) states that "Autograph software is one of the media that can be used in studying two-dimensional, three-dimensional, statistics, transformations, geometry, equations, coordinates, differentials, graphs, algebra, and others".

Therefore, the authors propose a study with the title "Development of Autograph-Assisted Problem-Based Learning Devices to Improve Students' Mathematical Problem Solving Ability".

2. Methode

Research Pattern

This research is a development research that is used to produce certain products and test the effectiveness of these products. To develop and validate the product, it is combined using the Thiagarajan 4D development model, which consists of four stages of development, namely: define, design, develop, and disseminate.

Subject and Object

The subjects in this study were students of class XI SMA Mentari Bangsa Medan in the academic year 2021/2022, while the objects in this study were learning tools developed through problem-based learning including lesson plans, Teacher's Books (BG), Student Books (BS), Participants Worksheets Didik (LKPD), a test of students' mathematical problem solving abilities.

Data Analisys

Data Analysis of Learning Device Validity

This validation is based on the opinion of five experts and practitioners in the field of education. Based on the expert opinion, the average value for each aspect will be calculated so that the average value for the total aspect is obtained.

Data Analysis Practicality of Learning Devices

Practical criteria by looking at opinions or responses from experts who state that learning tools using problem-based learning models can be used with little or no revision. The way to give an opinion about the practicality of this learning device is to provide a learning device assessment scale along with a learning device validation sheet according to the problem-based learning model.

The implementation of the learning device was observed by one observer who had been directed previously so that he could operate the observation sheet on the implementation of the learning device correctly. The implementation is in the form of 2 (two) choices, namely yes and no. If you choose yes then there are 5 (five) choices, namely: (1: very appropriate); (2: appropriate); (3: quite appropriate); (4: not suitable); and (5:very inappropriate). If the choice is not, then the value is 0 (zero).

Data Analysis of Learning Device Effectiveness

Data on the effectiveness of the learning tools developed were analyzed from: (1) data on student learning mastery, (2) achievement of learning objectives, and (3) student responses.

For the effectiveness of learning tools related to mathematical problem solving abilities, it is determined based on the achievement of classical student learning mastery. Minimum completeness is analyzed by considering that students can be said to be complete if the individual student scores reach a score of 70. This 70 score is the value of the Minimum Completeness Criteria (KKM) for class XI at Mentari Bangsa SMAS. Furthermore, a lesson is said to have been completed classically, that is, at least 85% of students who take the test have achieved a score of 70. Percentage of Classical Completeness (PKK) 85%.

Data Analysis Improving Concept Understanding Ability

To analyze the increase in students' understanding of mathematical problem solving, data were obtained from the results of the students' pre-test and post-test. The increase in students' understanding of mathematical problem solving can be obtained from normalized gain index data, as follows:

$$N - gain = \frac{\text{postest} - \text{pretest}}{\text{ideal value} - \text{pretes}}$$

With the criteria of Normalized Gain Index (g) shown in the following table:

Table 1. Normalized Gain Score Criteria

N-Gain Score	Category
$g > 0,7$	High
$0,3 < g \leq 0,7$	Medium
$g \leq 0,3$	Low

Adapted from Hake (Yohanis, J., Triwiyono, Modouw, 2013)

Data Collection Instruments and Techniques

Learning Tool Validation Instruments

The learning device validation instrument is a learning device validation sheet that is used to obtain data about the quality of learning tools based on the assessment of experts. Validation sheets for lesson plans, teacher books (BG), student books (BS), and student activity sheets (LKPD). This validation sheet contains the components that are assessed including: format, language, illustrations, and content.

Problem Solving Ability Test Instrument

The test instrument for mathematical problem solving ability is in the form of a structured description test.

Student Response Instrument

The instrument for student responses is a student response questionnaire which is an opinion or student response to the components and learning tools developed. The technique used to obtain student response data is carried out by distributing questionnaires to students. Student responses in this study were students' opinions of interest, feelings of pleasure, currentness, interest, and ease of understanding learning materials through learning tools developed through problem-based learning models.

Learning Media Development Procedure

a) Define Stage

The purpose of the definition stage is to determine and define learning needs by analyzing the objectives and limitations of the material. The activities carried out at this stage are early-late analysis, student analysis, concept analysis, task analysis, and specification of learning objectives.

b) Design Phase

The basis of the preparation of the test is the analysis of the concepts described in the specification of learning objectives. The test in question is a test of mathematical problem solving ability. To design a mathematical problem-solving ability test, a grid of questions is made based on indicators of mathematical problem-solving abilities and their scoring reference.

Media selection activities are carried out to determine the right media for the presentation of Derivative material. The media selection process is adjusted to the results of concept analysis and task analysis. From the results of the concept analysis, students are expected to be able to understand the concept of Derivatives. Thus, the suitable media are visual media, namely books and LKPD.

The selection of formats for RPP, Teacher's Book (BG), Student's Book (BS), and LKPD, is adjusted to the principle. Characteristics and learning steps of the PBM model. The selection of learning formats is also adjusted to the 2013 Curriculum. The RPP includes KI, KD, learning indicators, learning objectives, learning materials, learning activities, models, learning methods, learning resources, assessments, which consist of on the instrument, answer key, and scoring guidelines. The activity carried out in this step is writing the initial design of the learning device which includes the Teacher's Book, LKPD, and tests of students' mathematical problem solving abilities. This initial draft is referred to as draft 1.

c) Development Stage

The following details the steps taken at the development stage, namely:.

Validation/Expert assessment (Expert Appraisal)

In this activity an evaluation is carried out by experts in their fields. Expert validation is a technique to get suggestions for improvement as well as an assessment of the learning tools that have been produced at the design stage. The learning tools in question are all materials that have been developed at the design stage.

Trial of Research Instruments

The research instrument used in this study was a test of students' mathematical problem solving abilities. Before using the research instrument, the research instrument was first tested in a class outside the sample. Furthermore, validity and reliability tests were carried out. The purpose of this stage is to produce a good research instrument, in the sense that it is valid and feasible to use during field trials.

Field Trial

Field trials were conducted to obtain direct input on the learning tools that have been developed so as to produce the final tools. The learning tools were tested in schools to see the practicality and effectiveness of the learning tools that have been designed to improve students' mathematical problem solving abilities..

d) Stage of Dissemination

This activity was carried out in a limited manner in a discussion forum for mathematics subject teachers at SMAS Mentari Bangsa Medan. The result of this stage is to recommend to all mathematics subject teachers at SMAS Mentari Bangsa Medan to use this device as an alternative learning on Derivative material.

3. Result

Validation of Learning Devices by Using Problem Based Learning Tools by Using Developed

The research instrument used in this study was a test of students' mathematical problem solving abilities. Before using the research instrument, the research instrument was first tested on a class outside the sample, then the validity and reliability were tested. The goal is to produce a good research instrument, in the sense that it is valid and usable. The results of the validity and reliability test of the instrument are described as follows:

The validity of the questions was analyzed using the product moment person correlation formula, namely by correlating the score of the item with the total score. The results of the test instrument test of mathematical problem solving ability are presented in Table 1. below.

Table 1. Validity of Items for Mathematical Problem Solving Ability

Items	r_{xy}	t_{count}	t_{table}	Interpretation
1	0,7635	6,2558	1,7011	Valid
2	0,6273	4,2623	1,7011	Valid
3	0,7463	5,9330	1,7011	Valid
4	0,7990	7,0309	1,7011	Valid
5	0,7094	5,3260	1,7011	Valid

In Table 1. above, there is a trial of the research instrument for the problem-solving test for five essay questions with a significant level of 5%, dk = 28, obtained ttable = 1.7011. If referring to the test criteria is tcount > ttable, then the problem-solving ability test can be used or is valid. Thus, based on calculations performed manually and excel, it is concluded that the problem-solving ability test can be used or is valid. The results of expert and practitioner assessments on the practicality of PBM tools can be seen in Table 2. below: Practicality of Learning Tools by Using Problem Based Learning Tools by Using Developed Learning Tools.

Table 2. Learning Tool Validation Results

Validator	Learning Media				
	RPP	LKPD	BS	BG	TKPMM
Validator 1	RK	RK	RK	RK	RK
Validator 2	RK	RK	RK	RK	RK
Validator 3	RK	TR	TR	TR	RK
Validator 4	RK	TR	TR	TR	TR
Validator 5	RK	TR	TR	TR	TR

Information:
RK : Learning tools can be used with "minor revisions"
TR : Learning tools can be used "without revision"

In Table 2., it can be seen that experts and practitioners state that the Autograph-assisted PBM tool can be used with little revision and no revision. So, according to the practical criteria, the PBM equipment has met the practical criteria according to the expert. Furthermore, the practicality of the device will be tested in the field. The implementation of learning tools through PBM assisted by Autograph was measured using the PBM implementation observation sheet. The results of the data analysis on observing the implementation of PBM tools were concluded that the achievement of the implementation level of learning tools in the first trial was included in the high category, which means that the PBM tools were said to be practical or applicable.

Effectiveness of Learning Devices by Using Problem Based Learning Tools by Using Developed

PBM tools will be feasible to use if they can have a positive or significant impact on learning. Thus, the Autograph-assisted PBM device developed must meet the effectiveness criteria, namely: (1) classical student learning completeness, namely at least 85% of students who take part in learning are able to achieve a score of 70; (2) the achievement of learning objectives of at least 75%; (3) a minimum of 80% of the subjects studied gave a positive response to the components of the developed PBM equipment; and (4) the learning time is at least the same as ordinary learning. In the first trial, all of these things were not fulfilled, so the second trial was carried out again with a description of the effectiveness of the learning device.

The results of students' mathematical problem solving abilities in the pretest trial II were 63.33% while the classical completeness of students' mathematical problem solving abilities in the posttest trial II was 86.67%. In accordance with the criteria for mastery of classical student learning outcomes, at least 85% of students who take the math problem-solving ability test are able to achieve a score of 70. Thus, the results of the posttest of mathematical problem solving abilities meet classical completeness because they obtain a percentage of completeness of 86.67%. So it can be concluded that in the second trial the application of learning tools through the PBM device assisted by Autograph has met the criteria for achieving classical mastery.

the results of mathematical problem solving ability in the second trial, the achievement of learning objectives in question number 1 was obtained by 82.00%, the achievement of learning objectives for question number 2 was obtained at 80.67%, question number 3 was obtained by 78.67%, question number 4 obtained by 80.00%, and question number 5 obtained by 78.67%. In accordance with the criteria for achieving learning objectives, it is said that the learning objectives have been achieved with the criteria of 75% of the maximum score for each item. Thus the achievement of learning objectives in the second trial, namely the results of mathematical problem solving abilities have been achieved.

The results of the achievement of learning time in the second trial were six meetings. When compared with ordinary learning that has been carried out so far, there is no difference between the achievement of learning time using PBM learning tools in the first trial and the achievement of ordinary learning time.

Thus, it is known that the achievement of learning time using PBM learning tools in trial II is the same as the usual learning time carried out so far, namely six meetings with basic competencies: (1) explaining the properties of the derivative of algebraic functions and determining the derivatives of algebraic functions using definition or properties of derivative functions; (2) use the first derivative of the function to determine the maximum point, minimum point, and the monotony interval of the function, as well as the slope of the tangent to the curve, the equation of the tangent line, and the normal line of the curve related to contextual problems. This is in accordance with the learning time criteria, namely the achievement of the minimum learning time is the same as ordinary learning, thus the achievement of the second trial learning time has been achieved. Based on the results of the second trial data analysis, it is known that the learning tools developed have been effective.

Improving Students' Concept Understanding Ability

The analysis of increasing students' mathematical problem solving abilities in the first trial will be seen through the N-Gain from the results of the pretest and posttest mathematical problem solving abilities in the first trial. The results of the N-Gain calculation on mathematical problem solving abilities can be seen in the following table:

Table 3. Summary of N-Gain Results of Experimental Mathematics Problem Solving Ability I

N-Gain	Interpretation	The number of students
g ≤ 0,3	Low	0
0,3 < g ≤ 0,7	Medium	4
g > 0,7	High	26

Based on the table above, it can be seen that there were no students who scored N-Gain in the range of 0.3 or experienced an increase in their mathematical problem solving ability in the "low" category. For students who experienced an increase in their mathematical problem solving ability in the "medium" category or got an N-Gain score of 0.3 < g 0.7, there were 4 students and 26 students who scored an N-Gain g 0.3 or experienced an increase in ability. mathematical problem solving with the "high" category. So, the average gain in the first trial was 0.7 in the high category.

The analysis of increasing students' mathematical problem solving abilities in the second trial will be seen through the N-Gain from the results of the pretest and posttest of mathematical problem solving abilities in the second trial. The results of the summary of N-Gain mathematical problem solving abilities can be seen in Table 4. below:

Tabel 4. Summary of N-Gain Results of Experimental Mathematics Problem Solving Ability II

N-Gain	Interpretation	The number of students
g ≤ 0,3	Low	0
0,3 < g ≤ 0,7	Medium	4
g > 0,7	High	26

Based on the table above, it can be seen that there were 26 students who scored N-Gain in the range > 0.7 or experienced an increase in their mathematical problem solving ability in the "high" category. For students who experienced an increase in their mathematical problem solving ability in the "medium" category or got an N-Gain score of 0.3 < g 0.7, there were 4 students and no student who got an N-Gain g score 0.3 with the category " low". So, the average gain in the second trial was 3.83 in the high category. So, it can be concluded that there is an increase in students' mathematical problem solving abilities after implementing learning using the Autograph-assisted PBM device.

4. Discussions

Development of Learning Devices with Valid, Practical, and Effective Problem Based Learning Models

Based on the results of the validation of the problem-based learning tools developed, it was found that the components in the Learning Implementation Plan (RPP) were declared valid with good categories. Furthermore, the results of the validation of the Teacher's Book (BG), Student Book (BS), Student Activity Sheet (LKPD) and mathematical problem solving ability tests are also valid with good and understandable categories. This shows that the problem-based learning tools developed both the lesson plans, teacher books, student books, LKPD and test instruments have met the valid criteria.

Second, the problem-based learning tools developed have met construct validity. That is, in the development of problem-based learning tools, it is in accordance with the concepts and indicators of problem-solving abilities and mathematical dispositions which are then combined with problem-based learning. The learning tools developed were arranged to complement each other between lesson plans, teacher books, student books, and LKPD which were adapted to problem-based learning to measure students' problem-solving abilities and mathematical dispositions. The fulfillment of the good validity aspects above is in line with the opinion of Rahman and Amri (2013: 207) which states that the validity aspect refers to the extent to which the design of the developed device is based on content validity and construct validity. Akbar (2013:152) added that high validity was obtained through a validation test of the developed learning device.

The results of the research and opinions above are supported by development research conducted by Sinaga (2007) where, based on the results of expert validation and revisions that have been carried out, it is found that the development of learning models and tools carried out on lesson plans, teacher books, student books and worksheets is valid. both in terms of content and construct validity and can be applied. Furthermore, the same thing was revealed through the results of Frisnoiry's (2013) research based on the results of the development of learning tools that had met the valid criteria both in terms of content validity and construct validity. Fulfillment of these aspects, through expert validation and field trials of the developed learning tools.

Based on the results of the first trial, the second trial, and the results of the distribution, the Autograph-assisted PBM device developed has met the practical category in terms of the expert/practitioner's assessment which states that the developed learning device can be used with little or no revision and the implementation of learning is at good criteria.

Based on the results of expert assessments, the components of the learning tools developed in the form of lesson plans, Student Books (BS), Teacher Books (BG), Student Activity Sheets (LKPD), and students' mathematical problem solving ability tests are practical/can be used with revisions. small.

Based on the results of observations of the implementation of the Autograph-assisted PBM device, in the first trial, the learning implementation level was P = 3.93 in the second trial the learning implementation level was P = 3.80, and in the distribution results the learning implementation level was P = 4.03 is in the very high category with a minimum range ($4<P\leq5$) and the instrument is said to be good if it has a reliability coefficient of 0.75 or 75%. This aspect of the second practicality assessment is described as follows. The practical criteria in terms of the implementation of the learning tools in this study have also met the practical criteria. In experiments I and II, the implementation of learning tools has met the specified criteria, namely having reached the very high category and for the reliability of the problem-based learning instrument instrument in the implementation of experiments I and II have also reached the specified category, namely the instrument can be said to be good because it has reached the coefficient reliability 0.75 or 75%. Indeed, in the first trial, some students were still not familiar with the use of Autograph-assisted PBM learning tools that demanded student activity, but in the next trial the students became more accustomed and happy. Thus, it can be concluded that the Autograph-assisted PBM device developed is practical in terms of the implementation of the learning device.

Based on the results of the posttest analysis of the second trial and the results of the distribution, it was found that the ability to solve mathematical problems had met the criteria for classical completeness. This is because the learning materials and contextual problems that exist in student books and LKPD are developed according to the characteristics of students so that the learning process is more meaningful and students can do problem solving well.

Based on the results of the analysis of the achievement of learning objectives in the first trial, it was found that the achievement of the posttest learning objectives of mathematical problem solving abilities in the first trial was only achieved in item 1, while the achievement of the posttest learning objectives of mathematical problem solving abilities in the second trial had been achieved for each item. questions, as well as the results of the distribution.

Based on the results of the data analysis of the results of the first trial, the second trial, and the distribution results, it was found that the average percentage of student responses in each trial was positive, meaning that overall students felt helped and happy with the Autograph-assisted PBM tool that was developed. The student responses given in each trial have reached the predetermined criteria, namely 80%.

Based on the achievement of the learning time carried out during the first trial, the second trial, and the results of the distribution, the length of time for learning using the Autograph-assisted PBM device is the same as the usual learning time carried out so far, which is six meetings. Thus the learning time used is in accordance with the criteria for achieving learning time, namely the achievement of the learning time used does not exceed the usual learning time, so it can be concluded that the achievement of the learning time of trial I, trial II, and distribution results have been achieved and meet the criteria effectiveness.

Improving the Ability to Understand Mathematical Concepts by Using Problem Based Learning Devices by Using Developed

One of the objectives obtained from the development of learning tools in this study is to improve students' mathematical problem solving abilities. The improvement of students' mathematical problem solving abilities can be seen through a problem solving ability test based on the results of the pretest and posttest. Based on the results of the pretest and posttest, it can be concluded that the students' mathematical problem solving ability using the Autograph-assisted PBM device has increased. The increase in students' mathematical problem solving abilities can be seen from the average pretest and posttest results of problem solving abilities obtained by students in the distribution results. The mean score of the students' pretest was 58.26 and increased to 78.00 on the posttest.

The improvement of problem-solving abilities above is influenced by the characteristics of problem-based learning combined with learning tools developed. Among them: first, the learning tools developed contain authentic problems related to students' daily lives, are clear, easy to understand and useful. Second, the activities designed in the student book support the process of rediscovering a concept built by the students themselves. Third, problem-based learning is collaborative learning, meaning that in solving problems or tasks students must interact with the environment, fellow friends or teachers both in small groups and large groups. This is in accordance with Vygotsky's theory (Rusman, 2012) which states that Social interaction with friends spurs the formation of new ideas and enriches the intellectual development of students.

The results of this study are supported by the results of research by Nasution, Yerizon, and Gusmiyanti (2018). His research gave results with an average value of 82.29 for the experimental class and 70.27 for the control class. It can be seen that the mathematical problem solving ability of students who are taught with PBL is higher when compared to students who are taught by conventional learning. Other supporting research results are the research of Amalia, Surya, and Syahputra (2017) which states "The result showed that average value students who taught by using PBL were higher than students who taught by using conventional model. By using t-test, we know that significant value is less than 0.05, it means that learning by using PBL effective in improving the ability of mathematics problem solving for students". The results of this study indicate that the average score of students taught with PBL is higher than the conventional model. Learning using PBL is effective in improving students' mathematical problem solving abilities.

Then, the results of research by Ammamiarihta, Syahputra, and Surya (2017) stated, "Learning devices oriented Problem Based Learning were categorized as valid both in terms of content and construct, practical to use, and effective and students' mathematical problem solving ability increased" which means that the development of PBL-oriented learning tools is valid, practical, and effective, as well as increasing students' mathematical problem solving abilities.

Regarding the PBM model with a cultural context, the results of research by Lubis, Harahap, and Derlina (2017) stated, "The results obtained that the learning tool through learning-based model of learning based on Batak culture developed has met the valid, practical and effective criteria and there is an improvement of problem solving skills". This implies that PBL-based learning tools with the Batak cultural context are valid, practical, and effective and there is an increase in problem-solving abilities.

Learning by using PBM tools assisted by Autograph is interesting for students. The results of this study are in accordance with the research obtained by Yusra and Saragih (2016) which states that culture-based learning, which in this case is Malay culture, has a positive influence on mathematics learning.

Based on the description and results of previous studies above, it shows that learning with the PBM model is significantly better in increasing students' mathematical problem solving abilities. So it can be concluded that the PBM tool assisted by Autograph has a positive impact on increasing students' mathematical problem solving abilities.

5. Conclusion

Learning tools based on the Autograph-assisted Problem-Based Learning model are in the valid category with an average total value of RPP validation 4.6; LKPD 4.6; Student Book 4.6; Teacher's Book 4.7; and the student's Mathematics Problem Solving Ability test is valid for each item with a reliability value of 0.6337 (high reliability). The PBM tool assisted by Autograph meets the practical criteria, where: (1) the expert/practitioner assessment states that the learning device can be used with a few revisions, (2) the results of observing the implementation of learning tools in the classroom obtained an average value, namely in the first experiment of 3.93 (high / practical) and 3.80 (high / practical). The PBM tool assisted by Autograph meets the effective criteria, where: (1) student learning completeness in the first experiment is 66.67% (20 students) and in the second experiment it is 86.67% (26 students); (2) The achievement of learning objectives has been achieved with criteria greater than 75% of the maximum score for each item. In the first trial, the learning objectives on mathematical problem solving ability have not been achieved, obtained 79.70%, 74.70%, 70.30%, 72.00%, and 69.97%. However, after making several revisions, in the second trial the learning objectives were achieved, and the 1st objectives were 82.00%, 80.67%, 78.67%, 80.00%, and 78.67%. (3) The student's response to the components of the learning device is a positive response of more than 80%, and (4) the time used in the application of the Autograph-assisted PBM device does not exceed the usual learning time.

The problem solving ability of students using problem-based learning tools that were developed increased in terms of the average achievement of students' problem solving abilities, namely in the first experiment of 66.67%, increasing in the second experiment of 86.67%. The increase is also seen from the average N-Gain score of 2.50 which is in the high category.

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