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Development of Autograph-Based Learning Tools to Improve Mathematical Communication Skills Students in Vocational High School

Linda Sari; Edi Syahputra; Edy Surya

Universitas Negeri Medan, Indonesia

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Abstract

This study aims to describe: the development of Autograph-based learning tools is effective and able to improve mathematical communication skills. This research is development research with the Dick and Carey development model. This trial was conducted in class X RPL at vocational high school 14 Medan. From the results of test I and trial II, it was obtained: Autograph-based learning tools that were developed were effective, in terms of a) the criteria for student learning completeness were 86.11%; b) The achievement of learning objectives is more than 75%; c) students give a positive response; and d) the learning time is the same as the regular study time and (2) there is an increase in the average students' mathematical communication skills. Furthermore, it is suggested that teachers can use Autograph-based learning tools with problem-based learning models as an alternative to learning, with the guidance or questions are given that are affordable to students so that students understand more easily the contextual problems given.

Keywords: *Learning Tools; Mathematical Communication; Autograph; Problem-Based Learning*

Introduction

Mathematics is one of the subjects in school, from kindergarten to tertiary level. Mathematics lessons are one of the most important and fundamental lessons to be applied in all areas of life. The increasing need for mathematics in human life at large. In-Law No. 20 of 2003 concerning the National Education System states that "education is a conscious and planned effort to create an atmosphere of learning and the learning process so that students actively develop their potential to have religious-spiritual strength, self-control, personality, intelligence, noble character, and the necessary skills. himself, society, nation, and state". [1]

According to Purba and Surya [2], many students said that mathematics was difficult, complicated, boring, uninteresting, and unpleasant. They also say that they don't like math or other words that are negative for math. The main cause is a lack of understanding of what is being informed by the teacher, then the applied learning still relies on conventional learning. So they really do not understand what is being studied, which in the end they think as above and negative towards mathematics.

Initial ability of students is a determining factor in the success of learning mathematics. Each individual has different learning abilities. The initial ability of students is the ability that students have before they follow the learning that will be given. This initial ability (entry behavior) describes the readiness of students in receiving lessons to be delivered by the teacher. [3]

Education must really be made the foundation in order to use technology that is effectively applied by teachers as education suppliers. Suggesting that students understand this subject matter is influenced by the initial abilities they have. The formation of initial abilities is influenced by the quality of learning experienced by previous students. If previous learning is not effective, the learning outcomes are not in accordance with the objectives set. If this happens, then to continue or understand the next material students will experience difficulties because of the low level of knowledge they have from the previous material or prerequisite materials for the next material. [4]

NCTM (National Council of Mathematics Teachers,[5] has established several standard processes that students must master in mathematics, including:(1)learning to solve math problems (mathematical problem solving) (2)learning to communicate mathematically(mathematical communication); (3) learning to reason mathematically(mathematical reasoning);(4)learn to associate mathematical ideas (mathematical relationships); (5) learning to represent mathematics (mathematical representation).

Mathematical communication skills support other mathematical abilities, such as problem-solving abilities. With good communication skills, a problem will be represented correctly more quickly and this will support solving the problem. Mathematical communication skills are a prerequisite for solving problems. This means that if students cannot communicate properly interpreting problems and mathematical concepts then they cannot solve the problem properly.

However, the facts in the field show that students' mathematical communication skills rarely get attention. Teachers are more trying to make students able to answer questions correctly without asking for reasons for students' answers, or asking students to communicate their thoughts, ideas, and ideas.

According to Wahyudi [6] "the quality of education is determined by various dominant factors, among others; teachers, the leadership of the principal, school facilities and infrastructure including books, media/learning tools, school libraries, without exception a curriculum that suits the needs of students.

For a teacher, the existence of a learning device is an obligation that teachers must-have. For teachers, the completeness of learning devices is a weapon to carry out their duties and obligations. The learning device is a set of equipment that has been determined for teaching. Learning tools are an important part of the learning process.

But in his daily life, in the learning process, there are only general textbooks. Teacher manuals and student books are still rare. This is because teachers rarely make their own teaching materials. Nasution [7] the selection of good teaching materials has not received serious attention from teachers. In mathematics learning, the material taught is abstract objects. From Akker's statement [8] it is concluded that the quality criteria of a device are validity, practicality, and effectiveness.

Mareesh [9] in his research stated that the problem-based learning model is more effective in teaching mathematics. By adopting a problem-based learning model in teaching mathematics teachers can make a number of creative thinkers, critical decision-makers, problem-solving that is needed for a competitive world. As well as problem-based questions have an effect on content knowledge which provides greater opportunities for learners to learn content with more involvement and increases student

active participation, motivation, and interest among students. This causes students to have positive attitudes towards mathematics and helps them to improve their achievement.

With technological advances in learning, it includes the use of computers in research on the quality of learning. Computer programs are ideal for utilizing in learning mathematical concepts that require high accuracy, concepts, precise, fast, and accurate graphic completion. Computer-assisted learning innovations are very good to be integrated with learning mathematical concepts, especially those that transform geometry, calculus, statistics, and function graphics. One of the effective and efficient tools is to use signatures.

Autograph software is a medium that can be used to learn about two dimensions, three dimensions, statistics, transformations, geometry, equations, coordinates, differentials, graphs, algebra, and others. Autographs can improve scientific discourse in mathematics classrooms that lead students to experience learning investigations and solving mathematical problems. Autographs will help teachers and students to see the relationship between visual and symbolic representations and scientific discourse which will further create an environment for using correct terms and concepts that are explored.

Research Method

This research was conducted in the odd semester of the 2019/2020 school year. The subjects in this study were students of vocational high school 14 Medan class X RPL. The type of research used in this research is research and development (Research and Development). The development model used was the Dick & Carey development model. [10] This development is carried out to produce learning tools which will then be tested in class using The One-Group Pretest-Post test Design design, by not using a comparison class but already using the initial test so that the increase in students' mathematical communication skills can be ascertained.

Data Analysis Technique

Analysis of the Effectiveness of Learning Devices

The learning tools developed are declared to meet the effectiveness criteria as follows: (1) Analysis of Classical Student Learning Completion Achievement; (2) Analysis of Learning Objectives Achievement; (3) Analysis of the Improvement of Students' Mathematical Communication Ability; (4) Analysis of Student Response Data; (5) Data Analysis of Mathematical Communication Ability Tests.

Results

Identity Instructional Goals

Based on the identification of learning objectives in the 2013 curriculum, mathematics learning aims to make students have mathematical skills or proficiency. Mathematical skills or skills are part of the life skills that students must have, especially in developing reasoning, communication, and communication (problem-solving) faced in life.

Instructional Analysis (Conducting Objective Analysis)

The things that often happen in the process of learning mathematics, teachers are often more direct about the formula, then do exercises related to the material. Mathematical communication and

student responses are low. Based on the results of the observations, the researcher took the initiative to make an autograph-based student book as a way to make students improve their mathematical communication skills during the learning process.

Identity Entry of Behavior / Student Characteristics

Based on the test results of students' mathematical communication skills, it was found that students were not able to describe and model mathematical concepts. Based on interviews with mathematics teachers in schools, it is known that so far the emphasis on learning objectives has only focused on mastering concepts and knowledge

Write Performance Objectives

After analyzing the learning objectives contained in the curriculum and analyzing the students 'initial abilities, the researcher decided that the main objective in this study was to improve students' mathematical communication skills.

Development of Developing Standards (Develop Criterian-Referenced Test Items)

Based on the objectives that have been formulated, an assessment item is developed to measure students' mathematical communication skills. In this study, the developed test was adjusted to the absolute value equation and inequality subject matter. Once compiled, the test is then validated by experts, focused on content, language and question writing.

Develop Instructional Strategy

To improve students' mathematical communication skills, problem-based learning models are used. In the problem-based learning model students are encouraged to develop solutions to a problem in learning.

Develop and Select Instructional Materials

The learning tools to be developed in this study are student books (SB) and test instruments.

Design and Conduct Formative Evaluation

The formative evaluation in this study was carried out in 2 steps, namely: (1) one-on-one evaluation by experts, followed by revisions and instrument trials, and (2) field trials with large groups

Revision of Teaching Materials and Advanced Field Trials

Based on the results of the analysis of the learning tools in the first trial, data showed that the learning tools could not be said to be effective. For this reason, before trial 2 was carried out, revisions would be made to the learning devices used in trial I. Revisions would be made based on the weaknesses of the devices in a trial I.

Development and Implementation of Summative Evaluation

The main focus of this research is to produce autograph-based student books to improve students' mathematical communication skills. So that in this study summative evaluation is not carried out with several considerations, namely: (1) formative evaluation and summative evaluation cannot be linked as

two consecutive activities, but must be interspersed with implementations that take several years to implement, (2) it requires enormous costs given the wider scope of implementation and longer time.

Discussion

The effectiveness of Autograph-Based Learning Tools on the Developed Problem Based Learning Model

In determining effectiveness, it is seen from four aspects, namely classical student learning completeness, the achievement of learning objectives, student responses, and learning time. In the following, a discussion of each indicator will be presented in measuring or seeing the effectiveness of autograph-based learning tools.

a. Classical student learning completeness

Table 1 Level of Compliance in Pre-Test and Post-Test
Mathematical communication skills in Trial I

Category	*Pre-Test*	Percentage of Classical Completeness	*Post-Test*	Percentage of Classical Completeness
	Total students		Total students	
Completed	10	27,8 %	19	52,78 %
Not complete	26	72 ,2%	17	47,22 %
Total	36	100 %	36	100 %
Class Average	61,5		72,9	

Table 2 Level of Compliance in Pre-Test and Post-Test
Mathematical communication skills in Trial II

Category	*Pre-Test*	Percentage of Classical Completeness	*Post-Test*	Percentage of Classical Completeness
	Total students		Total students	
Completed	13	36,11 %	31	86,11 %
Not complete	23	63 ,89%	5	13,89 %
Total	36	100 %	36	100 %
Class Average	67,5		80	

Based on the results of data analysis that has been stated previously that in the first trial the percentage of classical completeness of mathematical communication skills was 52.78%, while in the second trial, the percentage of classical completeness of mathematical communication skills was 86.11%. When viewed from the results of classical student learning completeness mathematical communication skills, the mastery obtained from the results of the first trial did not meet the classical completeness criteria. Whereas in the second trial it had met the classical completeness criteria.

The results of the above research indicate that the students' mastery of classical learning using the developed learning tools fulfills the effectiveness criteria. This is because in the learning process using autograph-based learning tools, students find it easier to solve a mathematical problem by communicating the problems faced in schemes, pictures, and changing problems in mathematical models.

This is in accordance with the results of research by Kuntari and Rosnawati [12] which states that the problem-based learning model shows that the average post-test score is higher than the conventional class, the class using the problem-based learning model gets an average post-test score of 84, 25 for mathematical communication applications and problem abilities 85.05. Meanwhile, in the conventional class, the post-test score was 71, 64 and the problem ability was 69.34. Based on the average value of the problem-based learning model, it is more influential and significant than conventional in mathematical communication skills and problem problems.

This shows that students' mathematical communication uses autograph-based learning tools with problem-based learning models that have increased from trial I to trial II. Problem communication is that autograph-based learning tools with problem-based learning models can improve students' mathematics.

b. Achievement of Learning Objectives

Table 3. Achievement of Learning Objectives on Mathematical Communication Ability in Trial I

No	Learning objectives	Mathematical Communication Skills	
		% Learning Objectives Achievement	Description
1	Students are able to understand the concept of the absolute value of the linear form of one variable	78,70%	Achieved
2	Students are able to understand linear equations that involve the absolute value of the linear form of one variable and algebra of another	74,77%	Not achieved
3	Students are able to understand linear inequalities involving the absolute value of the linear form of one variable and algebra of another	69,91%	Not achieved

Table 4. Achievement of Learning Objectives on Mathematical Communication Ability in Trial II

No	Learning objectives	Mathematical Communication Skills	
		% Learning Objectives Achievement	Description
1	Students are able to understand the concept of the absolute value of the linear form of one variable	80,32%	Achieved
2	Students are able to understand linear equations that involve the absolute value of the linear form of one variable and algebra of another	80,09%	Achieved
3	Students are able to understand linear inequalities involving the absolute value of the linear form of one variable and algebra of another	82,41%	Achieved

Based on the results of the analysis of the results of the achievement of learning objectives in the first trial, the results of mathematical communication skills have not been achieved in items 2,3,4 and question number 5, while in trial 2 the achievement of learning objectives has been achieved for each item. Thus it is known that the achievement of the post-test learning objectives of students 'mathematical communication abilities in the first trial has not been achieved for each item, while the achievement of the post-test learning objectives of students' mathematical communication abilities in the second trial has been achieved for each item. the achievement of learning objectives in trial 2 has reached the predetermined category of criteria, namely ≥ 75%.

So it can be concluded that the achievement of learning objectives using autograph-based learning tools with problem-based learning models fulfills the effectiveness criteria.

In line with research by Fahmi, Syahputra, and Rajagukguk [13], it is stated that (1) the increase in reasoning and mathematical communication skills of junior high school students through the geogebra-assisted problem-based learning model is better than the increase in mathematical reasoning and communication skills of students who receive the ordinary learning model. (2) there is no interaction between learning and students' initial abilities to the ability to improve mathematical reasoning and communication. (3) the process of completing the answers of students whose learning using the Geogebra-assisted learning model is better than the ordinary learning model.

c. Student Responses to Autograph-Based Learning Tools with the developed Problem Based Learning Model

Based on the data analysis of the results of the trial I and trial II, it was found that the average percentage of student responses in each trial was positive. This means that overall students feel helped and happy with the use of Autograph-based learning tools with problem-based learning models that are carried out. Students who responded positively to each trial had reached the predetermined criteria category, namely ≥ 70%.

d. Learning Time

The results of learning time achievement in trial I and trial II were three meetings or 6 x 45 minutes. When compared with the usual learning carried out so far, there is no difference between the achievement of learning time using Autograph-based student books and test instruments and the achievement of ordinary learning time. Thus the learning time has met the effectiveness criteria.

Based on the overall results, namely the application of autograph-based learning tools based on problem-based learning in trials I and II, it was concluded that the effectiveness of autograph-based learning tools based on problem-based learning to improve students' mathematical communication skills had met the effectiveness limit which included classical completeness, achievement. learning objectives, student responses and learning time achievement.

With the fulfillment of the four indicators of the effectiveness of the developed learning tools, it can be concluded that the autograph-based learning tools based on the developed problem-based learning are effective.

Improving Students' Mathematical Communication Skills using the Autograph-Based Learning Tool developed

Table. 5 Summary of N-Gain Results. Mathematical communication skills Trial I

N-Gain	Interpretation	Number of Students
$g > 0,7$	High	0
$0,3 < g \leq 0,7$	Moderate	7
$g \leq 0,3$	Low	29

Table. 6 Summary of N-Gain Results. Mathematical communication skills Trial II

N-Gain	Interpretation	Number of Students
$g > 0,7$	High	2
$0,3 < g \leq 0,7$	Moderate	19
$g \leq 0,3$	Low	15

Based on table 5 above, it can be seen that there were no students who got an N-Gain score in the range> 0.7 or experienced an increase in mathematical communication skills in the high category. There were 7 students who experienced an increase in mathematical communication skills or got an N-Gain score of $0.3 < g \leq 0.7$ and students who experienced an increase in mathematical communication skills in the low category or got an N-Gain score $g \leq 0.3$ as many as 29 people. Based on the N-Gain calculation, it was obtained a score of 0.2 with the category of increasing low mathematical communication skills.

Based on table 6 above, it can be seen that students who got N-Gain scores in the range> 0.7 or experienced an increase in mathematical communication skills in the high category were 2 people. There were 19 students who experienced an increase in mathematical communication skills or got an N-Gain score of $0.3 < g \leq 0.7$ and students who experienced an increase in mathematical communication skills in the low category or got an N-Gain score $g \leq 0.3$ as many as 15 people. Based on the N-Gain calculation, a score of 0.4 was obtained with the category of moderate mathematical communication skills improvement.

Based on the results of the analysis of the increase in students' mathematical communication skills in trial I and trial II shows that the calculation of N-Gain to see an increase in students' mathematical communication skills in a trial I and trial II, the increase in students' mathematical communication skills based on the results of the pretest and post-test is in the moderate category.

Increasing students' mathematical communication skills is related to the use of autograph-based learning tools in the problem-based learning model that is carried out. In the problem-based learning model students are faced with non-routine problems whose resolution structure cannot be seen directly. This then trains students to develop their mindset so that students' communication skills increase.

Furthermore, in line with what was expressed by, Rambe and Surya [14] which stated that there was an effect of Problem Based Learning (PBL) on students' communication skills in mathematics learning. This study states that the mathematical communication skills of students who receive problem-based learning can affect students' mathematical communication skills.

Furthermore, in line with what was expressed by, Manalu, Napitupulu, Manulang, Simanjuntak, and Sinambela [15] stated that there are differences in students' mathematical problem-solving abilities between students taught with the scientific approach and the scientific approach based on autograph

software. So the use of autograph software contributes to improving students' mathematical problem-solving abilities.

Conclusions

The results obtained are as follows:

1. Autograph-based learning tools based on problem-based learning models in improving students' mathematical communication skills developed have met the effective criteria, namely:

   a. .Students' learning completeness criteria ≥ 85%. If seen from the results of the first trial, the completeness value was 52.78%, while for the second trial it was 86.11%, thus the completeness value of learning outcomes increased by 33.33%.
   b. Learning achievement is more than ≥ 75. If seen from the test results, the value of achievement of learning objectives in my trial is only that no 1 has been effective while questions 2,3,4 and question 5 have not been effective. Whereas in trial II all questions 1,2,3,4 and 5 were effective. This means that the error of learning objectives for trial II has been effective.
   c. The response given by students to the components of the Autograph-based learning device based on problem-based learning models and learning activities is a positive response.
   d. The learning time criterion, namely the minimum learning time is the same as ordinary learning in the trial, and trial II has been achieved. This means that the learning time criteria are effective.

2. Increasing students' mathematical communication skills using Autograph-based learning tools based on problem-based learning models is the calculation of N-Gain on students' mathematical communication skills in the trial I and trial II, increasing students' mathematical communication skills based on the results of the pretest and post-test are in the medium category.

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