Development of Learning Devices Based on Problem Based Learning Models in Improving Student's Concept Understanding Ability in 1 Sintahuis Junior High School

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Abstract. The research aims to: (1) describe the validity, practicality, and effectiveness of learning tools developed through a problem-based model for seventh grade students of junior high school 1 Sintahuis ; (2) Analyzing the improvement of students' conceptual understanding ability after using the developed device. This research uses the learning device development model of Thiagarajan, Semmel and Semmel, namely the 4-D model (Four D Model). This research was carried out in class VIII A in the odd semester of the 2021/2022 academic year Middle School. The results showed that (1) the problem-based learning model learning tools in improving students' mathematical concept understanding skills that were developed had met the valid, practical, and effective criteria; (2) Increasing the ability to understand mathematical concepts by using a problem-based model developed from the average N-gain value in the first and second trials.

Keywords: Learning development, problem based learning, Concept understanding ability

1 Introduction

Mathematics is one of the subjects taught at every level of education, from early childhood education to university level. Mathematics as one of the basic sciences, both its applied aspects and its reasoning aspects, has an important role in efforts to master science and technology. For this reason, school mathematics needs to function as a vehicle to develop intelligence, abilities, skills and shape students' personalities. Because in the process of learning mathematics there is a thought process, because in thinking humans make connections between parts of information that have been recorded in their minds as meaning. From this understanding, an opinion is formed which in the end can be drawn a conclusion. Along with the development of science and technology, the development of mathematics education has shifted. Sinaga (2007) says that:

Mathematics is an essential science as the basis for lifelong work in the era of globalization. Therefore, it is necessary to master mathematics at a certain level for all students so that later in life it is possible to get a decent job because in the era of globalization there is no job without mathematics. In fact, the quality of education is still low and must be improved, this is supported

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by the results of the World Competitiveness Year Book survey where Indonesia is ranked 37th out of 60 countries (IMD_WCY, 2015). Similar conditions can also be seen from the results of a study conducted by PISA (Program For International Student Assessment, where the results of the 2012 PISA study, Indonesia is ranked 64th out of 65 participating countries with an average score of 375, while the international average score is 375). 500 (OECD, 2014). On the other hand, there are still many teachers who still adhere to the old paradigm known as the transfer of knowledge in mathematics learning today. This paradigm assumes that students are objects or learning targets, so the teacher forces students more with formulas. - mathematical formulas or procedures and does not provide opportunities for students to use their understanding in solving student problems. Teachers are more focused on solving the demands of the mathematics learning curriculum and tend to be less effective in reflecting on the learning process and student learning outcomes, so this has a major influence on the low level t students' conceptual understanding ability in completing students. ' math problem.

This is in line with what was stated by NCTM (2000), the standard of abilities that must be achieved in learning mathematics include: (1) problem solving (problem solving); (2) Reasoning and proof (reasoning and proof); (3) communication (communication); (4) connecting ideas (connections); and (5) Representation. Students who have the ability to understand will understand the mathematical concepts they are learning, can provide patterns, solve problems, draw conclusions from concepts understood and provide conclusions as a result of clear thinking.

Referring to one of the standard processes, namely the ability to understand concepts is a very important ability for students to have because arithmetic is also closely related to mathematical characteristics. This phenomenon is also expressed by Ruseffendi (1991) that the largest part of mathematics that students learn in school is not obtained through mathematical exploration, but through notification. The situation in the field also shows that learning with the old paradigm makes students passive, causing a decrease in students' mathematical understanding. Students are not accustomed to thinking first to build their own knowledge so it is difficult to understand a concept. Students are accustomed to receiving learning from the teacher and only understand the forms of sample questions given by the teacher on the blackboard. Therefore, students' understanding of a concept is very important in learning mathematics because if students are directly involved in the formation of the concepts being taught, then students can easily solve mathematical problems in various forms according to the concepts that have been given.

However, in reality students' low conceptual understanding can be seen from the results of the researchers' initial research observations by providing questions that measure the ability to understand concepts in the Two Variable Linear Equation System material. to students of SMP Negeri 1 Sitahuis. Based on the test questions given, one of the indicators that students are expected to achieve is the ability to understand students' concepts. According to Wardhani (2008) it is explained that the indicators of understanding students' mathematical concepts are being able to "Restate a concept, Classify objects according to certain properties according to the concept, Give examples of concepts, Present concepts in.

2 Research methods

Types of research

This type of Development Research uses the Thiagarajan, Semmel and Semmel learning device development model, namely the 4-D model (Four D Model). Thus, the product of this research is a problem-based learning model learning device and the required instrument. The learning tools developed are lesson plans, teacher books, student books, student activity sheets and the necessary instruments, namely the concept understanding ability test.

Research subject

The subjects in this study were class VIIIA students of SMP Negeri 1 Sitahuis for the academic year 2021/2022, while the object in this study was a learning device based on the Problem Based Learning model on the material of the Two Variable Linear Equation System and the ability to understand concepts.

2.1 Data analysis

Data Analysis of Learning Device Validity

To see the validity of the learning tools used descriptive statistical analysis and based on the opinions of five experts in the field of mathematics education. Based on the expert opinion, the average value for each aspect will be determined, so that the average value of the total aspects is obtained.

Data Analysis of Practicality of Learning Devices

To get practicality data by using the implementation of learning devices. This instrument is used to obtain data on the implementation of learning devices. The implementation of the learning device was observed by two observers who had been trained so that they 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).

Data Analysis of Learning Device Effectiveness

The effectiveness of learning tools related to the ability to understand concepts is determined based on the achievement of classical student learning mastery. The data obtained from the posttest results of students' conceptual understanding abilities at the end of each lesson were analyzed to determine the percentage of students who have been able to understand the concept. Completeness of individual student learning is done by calculating the score of each student. Based on the 2013 Curriculum, a student is said to be complete if he gets a score of 71 with a B predicate. While learning completeness per class or the percentage of classical completeness (PKK) is obtained by calculating the percentage of students who complete individually. A class is said to have completed its learning if the PKK 85%.

Data Analysis Improving Concept Understanding Ability

To analyze the increase in students' understanding of mathematical concepts, data were obtained from the results of the students' pre-test and post-test. Increasing students' understanding of mathematical concepts can be obtained from normalized gain index data,

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

Table 1. Normalized Gain Score Criteria

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

2.2 Learning Media Development Procedure

In developing this mathematics learning media, the 4-D (Four-D) development model is used. According to Thiagarajan (1974), the 4D research and development model consists of 4 main stages, namely define, design, develop, and disseminate. According to Trianto (2013) the 4D development model can be adapted into 4D, namely definition, design, development, and deployment. The application of the main steps in the study is not only based on the original version but is adjusted to the characteristics of the subject and the place of origin of the examinee.

a) Define Stage

The purpose of this stage is to determine and define learning requirements by analyzing the objectives and limitations of the material. The activities carried out at the definition stage include 5 (five) main steps, namely (a) early-late analysis, (b) student analysis, (c) concept analysis, (d) task analysis, (e) specification of learning objectives.

b) Design Phase

The purpose of this stage is to design learning tools, so that prototypes (examples of learning tools) are obtained for cube and block material that refers to Problem Based Learning . Activities at this stage are test preparation, media selection, format selection and initial design of learning devices.

c) Development Stage

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

Validation/Expert assessment (Expert Appraisal)

Validasi atau penilaian ahli merupakan teknik untuk mendapatkan saran perbaikan as well as an assessment of the learning tools that have been produced at the design stage. In this step, draft 1 is evaluated by experts in the field. The experts referred to in this case are competent validators which include State University of Medan mathematics education lecturers and high school mathematics teachers. The results of expert validation are used as the basis for revising and perfecting learning tools. Furthermore, the results are revised according to the input given by the reviewer which then produces Draft II.

Research Instrument Trial

The research instrument used in this study was a test of the ability to understand concepts. Before using the research instrument, the research instrument was first tested in the class outside the sample, then tested for validity and reliability.

Field Trial

Field trials were carried out to obtain direct input to the learning tools that had been prepared so as to produce the final tools. The learning tools were tested at SMP Negeri 1 Sitahuis to see the practicality and effectiveness of the designed learning tools. The practicality of learning devices is observed by using an observation sheet on the implementation of learning devices. The criteria used to decide that a learning device has an adequate degree of implementation are at least in the high category (3≤P <4) or very high (4≤P 5) and the instrument is said to be good if it has a reliability coefficient of 0.75 or 75%. . Meanwhile, the effectiveness of the use of learning tools is measured by classical student learning mastery, namely at least 85% of students who take part in learning are able to achieve a minimum score of 75 on the ability to understand concepts.

d) Stage of Dissemination

The development of learning tools reaches the final stage if a positive assessment has been obtained from experts and through development tests. Learning tools are then packaged and distributed. The distribution of learning tools in this study was limited to class VIII of SMP Negeri 1 Sitahuis. At this stage, the effectiveness of learning tools that have been effective at the development stage are re-tested.

3 Result

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

This assessment is given to experts/practitioners at the same time as providing a device validation sheet. The results of giving the device validation sheet to the validator related to the response of the developed device can be seen in Table 2. below:

Table 2. Validator's Assessment of the Developed Tool

No.	Rated object	Average value of total validity	Validation Level
1.	Learning Implementation Plan	4,72	Valid
2.	Teacher's Book	4,83	Valid
3.	Student Book	4,76	Valid
4.	Student Worksheet	4,78	Valid

Based on Table 2. above, the average total validity of each learning device is in the interval: 4 Va < 5. Based on the validity criteria, it can be said that the learning tools developed are valid.

Practicality of Learning Devices by Using Problem Based Learning Devices by Using Developed

The implementation of problem-based learning-based learning tools was measured using an observation sheet on the implementation of problem-based learning-based learning tools. The implementation of the learning tools used is reviewed at each meeting. The implementation of all learning tools used in the study was observed by observers who are teachers in the field of mathematics studies. The recapitulation of observations related to the implementation of learning can be seen in Table 3. and Table 4. below:

Table 3. Recapitulation of Observation Results on the Implementation of Learning Devices in Trial I

No.	Aspects Observed and Assessed	Meeting				Average	Persentage
		I	II	III	IV		
1	Implementation of the Learning Implementation Plan	3,80	4,00	4,20	4,40	4,10	82%
2	Implementation of Student Worksheets	3,80	4,00	3,80	4,00	3,90	78%
3	Implementation and Teacher's Book	4,00	4,00	4,00	4,00	4,00	80%
4	Implementation and Student Book	4,00	4,00	4,00	4,00	4,00	80%
Average Execution		3,9	4,00	4,00	4,1	4,00	
Percentage of Execution		78%	80%	80%	82%	80%	

Based on Table 3. it is found that the average implementation of the learning tools developed in Trial I at the first meeting was 78%, for the second meeting it was 80%, for the third meeting it was 80% and for the fourth meeting it was 82%. Furthermore, the average value of the total implementation of learning tools from the four meetings is 80%.

However, on the implementation indicators, if it is reviewed based on each meeting, the first meeting has not reached the specified implementation criteria. This still needs to be re-examined and revised so that the implementation of the tools at each meeting and in each device as a whole meets the criteria for good implementation.

Furthermore, in the second trial, another observation of the implementation of all learning devices was carried out. Observation of the implementation of the previously revised learning device which was observed by 2 (two) observers. The recapitulation of observations related to the implementation of learning can be seen in Table 4. below:

Table 4. Recapitulation of Observation Results of Device Implementation Learning on Trial II

No.	Aspects Observed and Assessed	Meeting				Average	Percentage
		I	II	III	IV		
1	Implementation of the Learning Implementation Plan	4,20	4,60	4,60	4,40	4,45	89%
2	Implementation of Student Worksheets	4,20	4,00	4,00	4,60	4,20	84%
3	Teacher's Book Implementation	4,00	4,50	4,00	4,25	4,00	80%
4	Implementation and Student Book	4,20	4,00	4,20	4,00	4,00	80%
Average Execution		4,15	4,27	4,20	4,31	4,23	
Percentage of Execution		83	85	84,00	86	84,65	

Based on Table 4. it is found that the average implementation of the learning tools developed in Trial II at the first meeting was 83%, for the second meeting it was 85%, for the third meeting it was 84% and for the fourth meeting it was 86%. Furthermore, the average value of the total implementation of learning tools from the four meetings was 84.65%.

Based on Table 4. it can be seen that the average percentage in the four meetings meets the criteria for implementing learning tools in the very good category. As for the implementation of each device, the average percentage of implementation of the Learning Implementation Plan, Student Worksheet, Teacher's Book, and Student's Book has also met the implementation criteria in the very good category. This certainly has an impact on the overall implementation of learning tools for 4 (four) meetings which have an average implementation of 84.65% in the good category. In accordance with the reference in Chapter III regarding the implementation of the learning device, it is said to be successful if the implementation score is met in the $80 < k < 90$ percentage range in the "good" category. Thus, in Trial II, the implementation of learning using the developed learning tools was achieved.

From the results of the description above related to the implementation of learning tools, learning tools developed based on problem based learning can be said to be practical.

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

Description of the effectiveness of learning media assisted by Macromedia Flash is said to be effective if the level of students' mathematical reasoning abilities is at least 85% of the total number of students or a minimum score of 75.

Furthermore, the results of classical mastery of students' mathematical concept understanding abilities in the first try can be seen in Table 5. below:

Table 5. Classical Completeness Level of Concept Understanding Ability

Student Mathematics in Trial I

Category	Ability to understand mathematical concepts	
	The number of students	Percentage
Complete	14	70%
Not Complete	6	30%
Amount	20	100%

Based on the data in Table 5. it can be seen that the classical completeness of the results of the students' mathematical concept understanding ability in the first trial was 70% or as many as 14 students. In accordance with the criteria for mastery of classical student learning outcomes, namely at least 85% of students who take the mathematical concept understanding ability test are able to achieve a score of 75. Thus, the posttest results of students' mathematical concept understanding ability do not meet classical mastery because they only get 70% completeness percentage. . So it can be concluded that in Trial I the application of problem-based learning tools developed did not meet the criteria for achieving classical completeness.

Furthermore, the results of classical mastery of students' mathematical concept understanding abilities in the second trial can be seen in Table 6. below:

Table 6. Classical Completeness Level of Concept Understanding Ability Student Mathematics in Trial II

Category	Ability To Understand Mathematical Concepts	
	The number of students	Percentage
Complete	17	85%
Not Complete	3	15%
Amount	20	100%

Based on the data in Table 6. it can be seen that the classical completeness of the results of the students' mathematical concept understanding ability in the second trial was 85% or as many as 17 students. In accordance with the criteria for mastery of classical student learning outcomes, namely at least 85% of students who take the mathematical concept understanding ability test are able to achieve a score of 75. Thus, the posttest results of students' mathematical concept understanding ability have met classical mastery because they obtained a percentage of completeness of 85%. So it can be concluded that in Trial II the application of problem-based learning tools developed has met the criteria for achieving classical completeness. So, based on the results of the second trial, it can be concluded that the learning tools based on problem based learning have met the quality of effective learning tools.

Improving Students' Concept Understanding Ability

Based on the results of the pretest and posttest in the first trial, a summary of the results of N-Gain was obtained based on the improvement categories that have been set in Table 7. below.

Table 7. Summary of N-Gain Results of Concept Understanding Ability Test Student Mathematics I

Range	Upgrade Category	Total Students	Persentase
$N \geq 0,7$	High	1	5%
$0,3 \leq N < 0,7$	Medium	15	75%
$N < 0,3$	Low	4	20%

Based on Table 7. above, it can be seen that 1 student got an N-Gain score in the range > 0.7. For students who have increased their ability to understand mathematical concepts in the "Medium" category or get an N-Gain score of $0.3 < g$ 0.7, there are 15 students and 4 students who score N-Gain g 0.3 with "Low" category. The average gain in the first trial was 0.40, which is in the medium category. So, it can be concluded that there is an increase in students' ability to understand mathematical concepts after applying learning using problem-based learning tools in the first trial.

Based on the results of the pretest and posttest in the second trial, a summary of the results of N-Gain was obtained based on the improvement categories that have been set in Table 8.

Table 8. Summary of N-Gain Results on Comprehension Ability Test

Mathematical Concepts in Experiment IIMathematical Concepts in Experiment II

Range	Upgrade Category	Total Students	Persentase
N ≥ 0,7	High	6	30%
0,3 ≤ N < 0,7	Medium	13	65%
N < 0,3	Low	1	5%

Based on Table 8. above, it can be seen that 6 students obtained N-Gain scores in the range > 0.7 or experienced an increase in students' understanding of mathematical concepts in the "High" category. For students who experienced an increase in their ability to understand mathematical concepts in the "Medium" category or get an N-Gain value of 0.3 < g 0.7, there were 13 students and 1 student who obtained an N-Gain g value of 0.3 in the "Low" category. The average N-gain in the second trial was 0.58 which was in the medium category, so it can be concluded that there was an increase in students' ability to understand mathematical concepts after applying learning using problem-based learning tools in the second trial.

Based on Tables 6. and 7. if viewed based on the N-Gain calculation to see the increase in students' ability to understand mathematical concepts in the first try and second try it increased from 0.40 to 0.58, meaning that it was in the "medium" category. . This shows that the ability to understand students' mathematical concepts by using learning tools developed based on problem based learning has increased in the first trial to the second trial.

4 Discussion

The criteria for an effective device will also be seen from the achievement of student learning mastery through tests aimed at seeing how students' mathematical concept understanding abilities are. This criterion is met if more or equal to 85% of students are declared to have completed the KKM 75. Data analysis on students' mathematical concept understanding ability in the first test posttest of students' mathematical concept understanding abilities showed that there were 14 students out of 20 students completed or 70%. If referring to the criteria in CHAPTER III, the ability to understand mathematical concepts in the first trial did not meet the specified criteria.

In trial 2, the posttest of the ability to understand mathematical concepts showed that there were 17 out of 20 students who completed or 85%. Based on this, it can be concluded that the students' ability to understand mathematical concepts has met the predetermined criteria. This is because the quality of learning tools has been improved based on the weaknesses found in the first trial. This is in line with research conducted by Sianturi, Tetty and Frida (2018) which states that the ability to understand mathematical concepts of students who take part in learning with the Problem model Based Learning is higher than students who follow conventional learning. This shows that the Problem Based Learning model has an effect on the ability to understand students' mathematical concepts. In addition, it is also supported by research conducted by Nainggolan (2018), entitled "Development of Mathematics Learning Devices Through Problem-Based Learning to Improve Concept Understanding Ability of Class X Students of SMK YPK Medan" concluded that the group of students using the model was higher than the group of students using the model. with groups of students who use the conventional model.

Therefore, in this study it can be concluded that the problem-based learning tools developed can improve students' mathematical concept understanding abilities.

5 Conclusion

Learning tools based on problem-based learning in improving students' ability to understand mathematical concepts developed have met valid criteria, namely 1) RPP validation results validated by a team of experts with a total average of 4.72 with valid categories, 2) activity sheet validation results problem-based mathematics students with a total average of 4.78 with a valid category, 3) teacher book validation with a total average of 4.83 with a valid category, and 4) student book validation with a total average of 4.76 with a category valid and 5) validation of students' mathematical concept understanding test, where the expert team stated that it was valid.

Learning tools based on problem-based learning in improving students' ability to understand mathematical concepts meet practical criteria, namely 1) The response of a team of experts or validators stating that learning tools can be used with minor revisions (2) the implementation of problem-based learning tools used has an average 80% implementation with good category in trial I and 84.65% with good category in trial II.

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