

Development of Learning Devices Based on Problem Based Learning Models in Improving Students' Concept Understanding Ability

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Abstract
This study aims to: (1) describe the validity, practicality, and effectiveness of learning tools developed through problem based learning models in class VIII of SMP Negeri 1 Sitahuis; (2) To analyze the improvement of students' conceptual understanding ability after using the developed learning tools. This research is categorized into Development Research using the Thiagarajan, Semmel and Semmel learning device development model, namely the 4-D model (Four D Model). The research was carried out in class VIIIA in the odd semester of the 2021/2022 academic year at SMP Negeri 1 Sitahuis. The results showed that: (1) Learning tools with problem based learning models in improving students' mathematical concept understanding skills that were developed already met the valid, practical, and effective criteria; (2) Increasing the ability to understand mathematical concepts using learning tools with problem based learning models that have been developed seen from the average N-gain value in trial I and trial II, which are 0.40 and 0.58, respectively. medium category.
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1. Introduction

Mathematics is one of the subjects taught at every level of education, starting from early childhood education to the 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 to shape the personality of students. Because in the process of learning mathematics there is a thinking process, because in thinking people make relationships between parts of information that have been recorded in their minds as meanings. 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 knowledge as a basis for lifelong work in the age of globalization. Therefore, a certain level of mastery of mathematics is needed for all students so that later in their life it is possible to get a decent job because of 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 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 was ranked 64th out of 65 participating countries with an average score of 375, while the international average score 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 today's mathematics learning. This paradigm assumes that students are the object or target of learning, so teachers force students more with formulas. -mathematical formulas or procedures and do 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 an effect big against the lack of level t students' conceptual understanding ability in solving students' mathematical problems.

This is in line with what NCTM (2000) stated, the standard 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) linking ideas (connections); and (5) Representation (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 give conclusions as a result of thinking clearly.

Referring to one standard process, namely the ability to understand concepts is a very important ability for students to have because doing math is also closely related to the characteristics of mathematics. 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 using the old paradigm makes students passive, causing a decline in students' mathematical understanding. Students are not accustomed to thinking in advance to build their own knowledge so that 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 different forms according to the concepts that have been given.

However, in reality, the students' low understanding of concepts can be seen from the results of the observations of the researchers' initial research by giving questions that measure the ability to understand concepts in the Two Variable Linear Equation System (SPLDV) material to students of SMP Negeri 1 Sitahuis. Based on the test questions given, one of the indicators expected to be achieved by students is the ability to understand students' concepts. According to Wardhani (2008), it is explained that the indicator of students understanding mathematical concepts is being able to "Restate a concept, Classify objects according to certain properties according to the concept, Give examples of concepts, Present concepts in various forms of mathematical representation, Develop necessary or sufficient conditions. of a concept, Using, utilizing and selecting certain procedures, Applying concepts or algorithms to problem solving.Students' abilities on each indicator of concept understanding are scored according to criteria based on the rubric for assessing concept understanding.

Based on these factors, it can be concluded that the symptoms above are students' ability to understand concepts that are still low. Students' low conceptual understanding ability cannot be left alone, and students are not given enough verbal explanations, but students need to be given further understanding through direct experience to prove the truth of a concept for themselves. Because with understanding the concept students can solve math problems they have both orally and in writing.

To be able to improve students' conceptual understanding skills, a supportive learning device is needed. Poppy (2009) said that "Learning device is a device used in the teaching and learning process". This is in accordance with Government Regulation No. 19 of 2005 concerning national education standards which states that one of the standards that must be developed is the process standard.

Books are tools that support learning. Akbar (2013) defines textbooks as textbooks that are used as standard references in certain subjects. The development of a good textbook must meet the criteria of being valid and effective.

In addition to textbooks on learning tools, other devices are also needed that help students understand the material given. The Student Activity Sheet (LKPD) is one that supports student textbooks. LKPD is a learning tool designed to help students understand the subject matter through a structured activity with various problems given. Orlich, et al (2010) said that the activity sheet will help students engage in learning with various forms of activities that involve various skills.

Starting from the above phenomenon, learning tools occupy an important position in achieving learning objectives, as explained by Haggarty and Keynes (Muchayat, 2011) that in order to improve teaching and learning mathematics in the classroom, efforts are needed to improve the understanding of teachers, students, and materials used in the classroom. used for learning and interaction between them.

Responding to problems that arise in learning mathematics as described above, especially related to the ability to understand students' concepts which ultimately lead to low student learning outcomes in learning mathematics, it is necessary for teachers or researchers to choose learning that can change the paradigm. The initial step that can be taken by the teacher is the selection of Problem Based Learning Learning Model (Problem Based Learning) is one solution, because Arends (2008) states that the problem-based learning model is a learning model with a student learning approach to authentic and meaningful problems to students who serves as a basis for student investment and investigation, so that students can construct their own knowledge, develop higher skills and inquiry, become self-reliant, and increase student confidence. This model is characterized by using real-life problems as something and improving critical thinking and problem solving skills, as well as gaining knowledge of important concepts.

According to Trianto (2010) in the problem-based learning model, small groups of students work together to solve problems that have been agreed upon by students and teachers. When the teacher is applying the learning model, students often use a variety of skills. The relationship between problem-based learning and mathematics is a learning approach that begins with exposing students to mathematical problems. With all their knowledge and abilities, students are required to solve problems that are rich in mathematical concepts.

Based on the problems above, the authors are excited to conduct research on "Development of Learning Devices Based on Problem Based Learning Models in Improving Students' Concept Understanding Ability.

2. Methode

Research Pattern

This type of research is included in the type of Development Research using 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 necessary instruments. The learning tools developed are learning implementation plans, teacher books, student books, student activity sheets and the necessary instruments, namely a concept understanding ability test.

Subject and Object

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.

Data Analisys

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 Practicality of Learning Devices

To get practicality data by using the implementation of learning tools. 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 student learning individually 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. Meanwhile, 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. The increase in students' understanding of mathematical concepts 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)

Learning Media Development Procedure

In the development of mathematics learning media assisted by Macromedia Flash, 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 examinee's place of origin.

a) Define Stage

The purpose of this stage is to determine and define the learning requirements by analyzing the objectives and limitations of the material. The activities carried out in 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 PBL. Activities at this stage are preparation of tests, selection of media, selection of formats 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)

Validation or expert assessment 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. In this step, draft 1 is evaluated by experts in the field. The experts referred to in this case are competent validators which include UNIMED mathematics education lecturers and high school mathematics teachers. The results of the validation of the experts are used as the basis for revising and perfecting learning tools. Furthermore, the results have been revised in accordance with the inputs given by the reviewers which then produce Draft II.

Trial of Research Instruments

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 on a class outside the sample, then the validity and reliability were tested.

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 was observed by using the 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 ($3 \leq P < 4$) or very high ($4 \leq P$ 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 these learning tools is measured by classical student learning mastery, namely at least 85% of students who take part in the 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 SMP Negeri 1 Sitahuis. At this stage, the effectiveness of learning tools that have been effective at the development stage are re-examined.

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 tools is measured by 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	the meeting				Average	%
		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 Observations on the Implementation of Learning Devices in Trial II

No.	Aspects Observed and Assessed	the meeting				Average	%
		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	Implementation and Teacher's Book	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 Students' Mathematical Concept Understanding Ability 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 5. below:

Table 5. Classical Completeness Level of Students' Mathematical Concept Understanding Ability 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 5. 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 mastery. 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 6. below.

Table 6. Summary of N-Gain Results of Students' Mathematical Concept Understanding Ability Test I

Range	Category Increase	Number of Students	Percentage
$N \geq 0,7$	High	1	5%
$0,3 \leq N < 0,7$	Medium	15	75%
$N < 0,3$	Low	4	20%

Based on Table 6. 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 7. below.

Table 7. Summary of N-Gain Results on Ability Test of Mathematical Concept Understanding in Trial II

Range	Category Increase	Number of Students	Percentage
$N \geq 0,7$	High	6	30%
$0,3 \leq N < 0,7$	Medium	13	65%
$N < 0,3$	Low	1	5%

Based on Table 7. above, it can be seen that 6 students got an N-Gain score in the range > 0.7 or experienced an increase in the ability to understand mathematical concepts of students in the "High" category. 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 13 students and 1 student who scores an N-Gain g 0.3 in the category "Low". The average N-gain in the second trial was 0.58, 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 second trial.

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

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 model learning tools developed, it was found that the problem based learning model learning tools, namely the Learning Implementation Plan (RPP), Teacher Books (BG), Student Books (BS) and Student Worksheets (LKPD) were declared valid or had good degree of validity. Furthermore, the results of the validation of the student's mathematical concept understanding ability test are also valid or have a good degree of validity. This shows that the problem-based learning model learning tools developed both RPP, BG, BS, LKPD, students' mathematical concept understanding ability tests and self-efficacy questionnaires have met the validity criteria.

The developed device is said to meet valid indicators if the problem based learning model learning device is at least in the assessment category. From the results of the validation carried out, the average total value of validation for: (1) Learning Implementation Plan (RPP) is 4.72;; (2) Teacher's Book (BG) of 4.83; (3) Student Books (BS) of 4.76 and (4) Student Worksheets (LKPD) of 4.78. Based on the validity criteria, it can be said that the learning tools developed are valid. This is in accordance with the results of Dahlia's research (2016) that the problem-based learning tools developed meet the valid criteria.

For further practical assessment, in terms of the implementation of the learning tools in this study, they have also met the practical criteria. In the first trial and the second test, the implementation of the learning tools has met the established criteria, namely that it has reached the good category ($80 \leq k < 90$). This is supported by the results of research by Mukasyaf, Fikri (2018) which shows that the development of learning tools with a problem based learning model approach that was developed meets practical criteria.

Based on the description above, it can be concluded that the learning tools developed with the problem based learning model have met the practicality as expected. Thus, the problem-based learning model developed is easy and can be implemented by teachers and students.

Based on the results of the posttest analysis previously stated that in the first trial the percentage of classical mastery of mathematical concept understanding ability was 70%, while in the second trial the percentage of classical mastery of mathematical concept understanding ability was 85%. When viewed from the results of students' learning mastery classically, the students' mathematical concept understanding ability, the mastery obtained from the results of the first trial did not meet the criteria of classical completeness, while the second trial met the criteria of classical completeness.

The results of the research above indicate that the classical student learning completeness with the developed learning tools meets the effectiveness criteria. This is because by applying the problem-based learning model learning tools students are actively involved in solving problems. This is supported by the results of research by Mukasyaf, Fikri (2018) which concludes that the learning tools developed based on problem based learning meet the effective criteria indicated by the students' individual and classical learning mastery being met.

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

The criteria for an effective device will also be seen from the achievement of student learning completeness 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 complete who meet 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 improvements in the quality of learning tools have been made based on the weaknesses found in trial I. 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 (PBL) is higher than students who follow conventional learning. This shows that the Problem Based Learning (PBL) model affects 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 and Self Efficacy of Class X Students of SMK YPK Medan" concluded that the group of students using the PBL model was higher than the group of students using the PBL model. with a group 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 and self-efficacy of students that have been developed have met the valid criteria, namely 1) RPP validation results validated by a team of experts with a total average of 4.72 with valid categories, 2) validation results problem-based mathematics student activity sheets 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 valid categories and 5) validation of students' mathematical concept understanding tests, where the expert team stated 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 implementation of 80 % with good category in trial I and 84.65% with good category in trial II. Learning tools based on problem-based learning in improving students' ability to understand mathematical concepts meet the effective criteria, namely classical completeness reaching 85%, which has met the completeness criteria, namely 85% of students achieving KKM.

Increasing the ability to understand mathematical concepts using learning tools based on problem-based learning that has been developed can be seen from the average N-gain value in the first trial and second trial of 0.40 and 0.58, which are in the medium category.

REFERENCES

Akbar, S. (2013). *Instrumen Perangkat Pembelajaran*. Bandung: Remaja Rosdakarya.

Akker, J. Van den. 1999. *Principles and Method of Development Research*. Akker, J. (2013). Curricular Development Research as A Specimen o Educational Design Research. Dalam Plomp, T., & Nieveen, N. (Eds). (2013). Educational Desain Research- Part A : an introduction. *Netherlands : Netherlands Institute for Curriculum Deveopment (SLO*).

Akker, J. Van den. 1999. *Principles and Method of Development Research*. London. Dlm. van den Akker, J., Branch, R.M., Gustafson, K., Nieveen, N., & Plomp, T. (pnyt.)". Design approaches and tools in educational and training .Dordrecht: Kluwer Academic Publisher.

Arends, R.I (2008). *Learning to Teach.* Buku Dua. *Edisi Ketujuh.* Yogyakarta: Pustaka Pelajar.

IMD WCY. (2015). *Methodology and principles of analysis. IMD world competitiveness yearbook*. Switzerland: Lusanne

Muchayat. (2011). Pengembangan Perangkat Pembelajaran Matematika dengan Strategi *Ideal Problem Solving* Bermuatan Pendidikan Karakter. *Jurnal PP* (Online), Vol 1, No. 2, (http://journal.unnes.ac.id/nju/index.php/jpppasca/ article/ download/1545/1721, diakses 11 oktober 2014).

Mukasyaf, F. (2018). Lintasan Belajar Kemampuan Pemecahan Masalah Siswa Berbasis Pendekatan Metakognisi Topik Gsl Di Smp Imelda Medan. *Jurnal Penelitian Bidang Pendidikan.* Vol 24, No 1 DOI: https://doi.org/10.24114/jpbp.v24i1.12104

National Council of Teachers of Mathematics. (2000). *Principles and Evaluation Standards for school Mathematics.* Reston, VA: NCTM.

OECD. 2014. *Education at a Glance 2014: OCD Indicators*. OECD

Orlich, Donald C. et al. (2010). *Teaching Strategies a Guide to Effective Instruction*. USA : Wadsworth

Palobo, M., & Nur'aini, K. (2018). Pengembangan Perangkat Pembelajaran Berbasis Problem Based Learning Berorientasi pada Peningkatan Kemampuan Penalaran dan Sikap Siswa Terhadap Matematika. *Magistra: Jurnal Keguruan Dan Ilmu Pendidikan*, *5*(2), 015-029. https://doi.org/10.35724/magistra.v5i2.922

Poppy, K. D, dkk. (2009). *Pengembangan Perangkat Pembelajaran. Bandung*: P4TK IPA.

Ruseffendi, E. T. Dkk. (1991). *Pendidikan Matematika 3*. Jakarta: Depdikbud.

Sinaga, B. (2007). *Pengembangan Model Pembelajaran Matematika Berdasarkan Masalah Berbasis Budaya Batak (PBM-B3)*. Disertasi. Surabaya:Program Pascasarjana Universitas Negeri Surabaya.

Thiagarajan, Sivasailam, dkk. (1974). *Instructional Development for Training Teachers of Exceptional Children*. Washinton DC: National Center for Improvement Educational System.

Trianto. (2010). *Model Pembelajaran Inovatif-Progresif Konsep, Landasan, dan Implementasi Pada Kurikulum Tingkat Satuan Pendidikan (KTSP)*. Jakarta: Kencana.

Trianto. (2013). *Mendesain Model Pembelajaran Inovatif, Progresif, Konsep, Landasan, dan Implementasinya Pada Kurikulum Tingkat Satuan Pendidikan (KTSP)*. Jakarta: Kencana Prenada Media Group.

Wardhani, S. (2008). *Analisis SI dan SKL Mata Pelajaran Matematika SMP/MTs Untuk Optimalisasi Pencapaian Tujuan.* Yogyakarta: PPPPTK Matematika

Yohanis, J., Triwiyono, Modouw, W. (2013). Pengembangan Modul Pembelajaran Fisika Bilingual Kelas X Pokok Bahasan Gerak Lurus di SMA Negeri 3 Jayapura. *Urnal Ilmu Pendidikan Indonesia.*, *I*, 10–19. https://garuda.kemdikbud.go.id/author/view/575956