RESEARCH ARTICLE

The Development of Problem Solving To Improve Understand Mathematical Concepts

Irin Irawati Sirait[1], Haninda Bharata[1] Asmiati[1]

[1] Master Program of Mathematic Education, Lampung University, Lampung, Indonesia
Corresponding Author : siraitirin@gmail.com

ABSTRACT

This study aims to 1) develop a problem solving learning model that is oriented towards the ability to understand mathematical concepts, 2) test the feasibility of a model developed on algebraic function derived material, and 3) test the effectiveness of the product of development. This study refers to the Research and Development procedure of Borg and Gall which is simplified into six stages and the resulting product is refined with ASSURE learning design theory. Data were analyzed with qualitative descriptive methods and cognitive learning outcomes with normalized N-gain to determine the effectiveness of the model, Independent t-test to determine differences in learning outcomes. The results were obtained through tests of mathematical concept understanding ability. The results showed that 1) the development of the learning model was carried out with due regard to the components of the model, 2) the results of the development of the learning model were feasible to be applied to the material derived from algebraic functions, 3) the developed learning model was able to improve the ability to understand mathematical concepts. The results of the study can be concluded that the problem solving learning model oriented on the ability to understand mathematical concepts is more effective than conventional learning models.

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1. INTRODUCTION.

In the world of education, mathematics is one subject that is always influential for other subjects as well as in everyday life. This is in accordance with Abdurrahman's statement (2012) that mathematics needs to be taught to students because it is always used in all aspects of life, all fields of study require appropriate mathematical skills, and provide satisfaction with efforts to solve challenging problems. Thus it is very natural that the position of mathematics becomes very important to learn for anyone, from school or in daily life.

The most important factor in the process of learning mathematics is the role of the teacher because the teacher is directly dealing with students. Hudojo (2001) states that the teacher's role in assessing student success is not enough just from the results of the test/test but also by continuously monitoring students during the activity so that the desired objectives in the learning process can be achieved. Furthermore it is said that the process of learning mathematics will occur smoothly if learning is carried out continuously.

Every learning process in an education must have goals to be achieved. Chent and Wang (2016) state that the goal of mathematics education is to have students who truly understand mathematical concepts rather than just memorizing. This is in line with the statement of the Depdikbud (2016) that mathematics educ-

ation in schools is expected to contribute to students being able to understand concepts and apply mathematical procedures in everyday life. Thus, the ability to understand mathematical concepts is very necessary in the process of learning mathematics in schools.

According to Murizal (2012) understanding of mathematical concepts is very important because understanding of mathematical concepts is the basis for learning mathematics meaningfully. Understanding the concept consists of two words, namely understanding and concepts. Purwosusilo (2014) states that students 'mathematical understanding ability is the ability students have in understanding concepts, understanding formulas and being able to use these concepts and formulas in calculations, as well as students' understanding of schemes or structures that can be used in broader problem solving and the nature of its use is more meaningful.

The definition of conceptual understanding (conceptual understanding) according to Kilpatrick, Swafford & Findell (2001) is as the ability of students to understand concepts, operations and relationships that exist in mathematics. Someone who has an understanding of the concept will be able to construct the meaning obtained from messages that arise during the learning process both through oral and written communication. Understanding concepts is the most important part in learning mathematics.

Mathematics itself is a science that is systematically organized in a series of logical sequences (Suherman, 2003). The concepts in learning mathematics are arranged in a hierarchical, structured, logical and systematic manner from the simplest concepts to the most complex concepts. In mathematics there are prerequisite concepts as a basis for understanding a topic or a further concept. This is in line with the statement of Zulkardi (2003) which states that mathematics emphasizes concepts. This means that when students learn mathematics, understanding mathematical concepts must first be owned by students to be able to solve problems and be able to apply the learning in everyday life.

But in reality, students' understanding of mathematical concepts in Indonesia is still relatively low, as seen from the results of Indonesia's achievements in PISA. This is because to be able to solve real problems in PISA problems, students must go through a mathematical process that involves understanding mathematical concepts (Wijaya, 2012). In addition, being able to apply concepts in problem solving is one indicator of students understanding mathematical concepts (Wardhani, 2008).

The acquisition of Indonesian students' mathematics scores in PISA in 2012 was 375, below the International average score of 494 (OECD, 2014). In addition, the acquisition of Indonesian students' mathematics scores in PISA in 2015 was 403, below the International average score of 493 (OECD, 2016). This is an indication that students' understanding of mathematical concepts in Indonesia is quite low.

The fact is also seen in the results of observations, found that many students have difficulty in understanding mathematical concepts. Students have difficulty solving questions that are different from the examples given by the teacher. Students only focus on the examples given by the teacher. Students are still unable to fully express the concepts they have learned, as well as using concepts in problem solving. In addition, based on the results of interviews with teachers who teach also, students are accustomed to memorizing mathematical formulas provided, not understanding the mathematical concepts. This indicates that the ability to understand students' mathematical concepts is still relatively low.

There are still many students who have low mathematical concept comprehension skills because of the mathematics learning process implemented by teachers in schools. Learning in schools today is still dominated by teachers. The teacher directly provides the material. Students are less actively involved in constructing their own knowledge to understand the concepts learned. Students are not much involved in constructing their knowledge, only receive information that is delivered in the same direction from the teacher. Often students are not able to answer questions that are different from the examples given by the teacher. This is because students only hear the teacher's explanation, copy, and do the exercises following the pattern given by the teacher, not because students understand the concept.

According to Shadiq (2009) that the learning model as described above, can be said to emphasize more students to remember (memorize) or memorize (rote learning) and less or even not to emphasize students to reason (reasoning), solve problems (problem solving) or on understanding (understanding). The learning model is still used by the teacher at the time of observation. Thus, the learning model that is one of the causes of students' understanding of mathematical concepts is low.

Teachers should always have new ideas to develop learning such as learning models that must support students' understanding of mathematical concepts. According to Rusman (2010) the learning model is a plan or pattern that can be used to shape the curriculum (long-term learning plan), design learning materials, and guide learning in the classroom or others. Thus, the teacher must prepare good learning by developing learning models that can develop the ability to understand mathematical concepts. One learning model that can develop the ability to understand mathematical concepts is problem solving.

According to Hamalik (1999) problem solving is a mental and intellectual process in finding problems and solving them based on accurate data and information, so that conclusions can be drawn accurately and accurately. This is in line with the statement Janawi (2013) states that the problem solving learning model is a learning model in which students are faced with a problematic condition. Thus, the problem solving learning model is a learning model that can help students find answers based on knowledge, understanding that they have before in order to draw appropriate conclusions. In other words, the problem solving learning model requires students to use mathematical concepts that they have to answer a problem. The more students use the concepts they have, the more the ability to understand mathematical concepts.

The problem formulation in this research is how is the process and results of developing problem solving learning models to improve the ability to understand mathematical concepts? and how the effectiveness of the results of the development of problem solving learning models to improve the ability to understand mathematical concepts ?.

The problem solving learning model used in this study uses the Polya model. Polya (1957) states that there are four stages of problem solving, namely understanding the problem, making a problem solving plan, implementing a problem solving plan, and reviewing it. The four stages of Polya are as follows.

a. Understanding the Problem

Understanding the problem leads to the identification of information, facts needed to solve the problem. At this stage, students must be able to determine things or what is known and things or what is asked. If needed, students can make diagrams or tables or sketches or graphs. This is intended to make it easier to understand the problem and get an overview of the solution. Students are also required to know what is asked, which will be the direction of problem solving.

b. Devising a Plan

Making a plan refers to modeling a known problem. At this stage, strategies often used include guessing and checking, making diagrams or pictures, trying on simpler problems, testing all possibilities, and sorting data / information.

c. Carrying out the plan

Carrying out the plan refers to the process of calculating and completing a mathematical model by checking the truth at each step each time.

d. Looking back

Revisiting can be interpreted as the stage of checking the correctness of the steps of the answer.

The design of the problem solving learning model developed is a problem solving learning model oriented with the ability to understand mathematical concepts. This is because the desired goal in research is that the model developed can improve the ability

to understand mathematical concepts.

Following this design development of problem solving learning model oriented ability to understand mathematical concepts as follows.

1. In the first stage, the stage of understanding the problem is added an indicator of the ability to comprehend the fifth mathematical concept that is linking with other concepts.

2. In the second stage, the stage of making a problem-solving plan is added an indicator of the ability to understand mathematical concepts second and third, namely classifying objects based on whether or not the requirements to form the concept and

present the concept in various forms of mathematical representation.

3. In the third stage, the stage of implementing the problem solving plan is added an indicator of the ability to understand the fourth mathematical concept that is applying the concept in an algorithmic way.

4. In the fourth stage, the review stage is added again an indicator of the ability to understand the first mathematical concept that is to restate the concepts that have been learned.
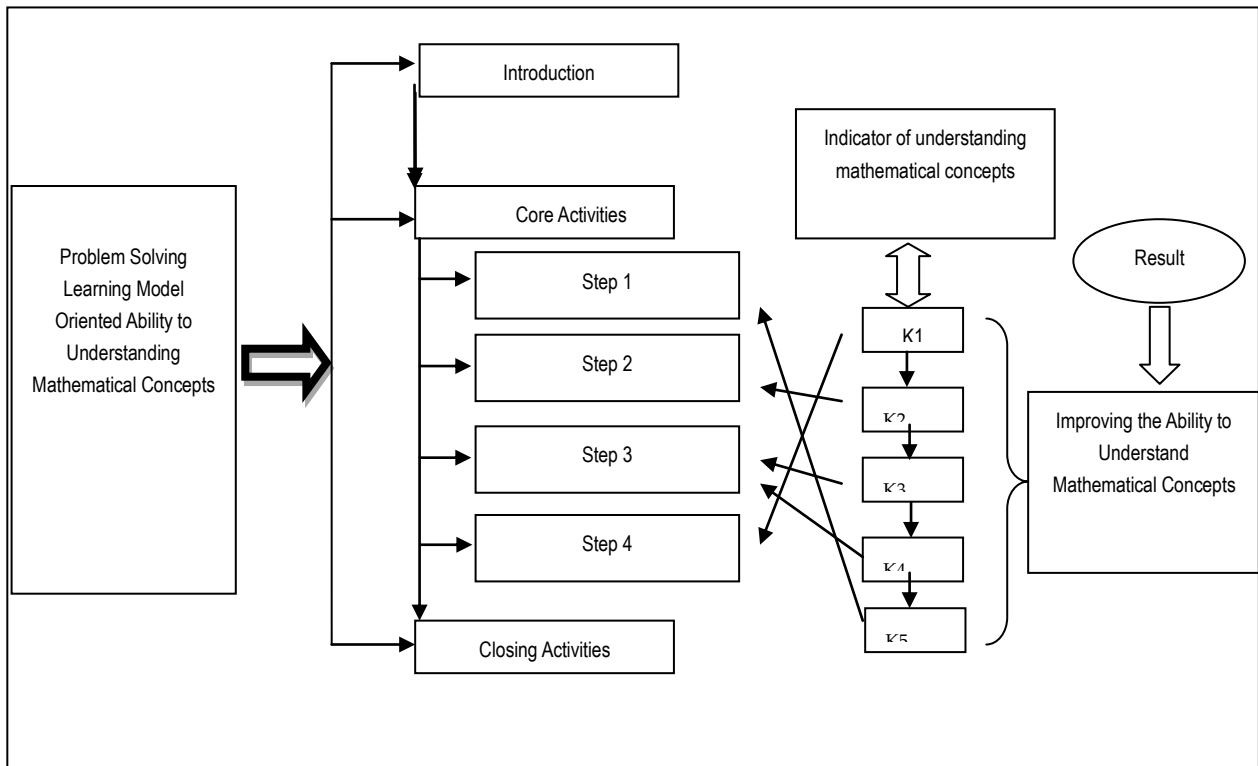

Figure 1. The development chart of problem solving learning model is oriented towards the ability to understand mathematical concepts

The design of the development of the problem solving learning model in this study is to use the ASSURE learning development design according to Heinich. The stages are 1) Analyze learner, 2) State objectvivies, 3) Select methods, media and materials, 4) Utilize materials, 5) Requires learner participation and 6) Evaluate (ASSURE). The steps of the ASSURE development design model are described as follows.

1) Analyze learner (student analysis/analysis of student characteristics)

The initial step that needs to be done in implementing this model is to identify the characteristics of students who will be doing learning activities. a good understanding of student characteristics will greatly help students in their efforts to achieve learning goals. Analysis of student characteristics includes several important aspects, namely general characteristics, specific characteristics that have been previously owned and student learning styles.

2) State objects (state goals)

The next step is to set specific learning goals. Learning objectives can be obtained from the syllabus or curriculum, information recorded in textbooks, or formulated by the designer himself. Learning objectives are formulations or statements that describe the knowledge, skills and attitudes obtained by students

after taking the learning process. Pribadi (2011) states in addition to describing the competencies that need to be mastered by students, the formulation of learning objectives also describes the conditions needed by students to show the learning outcomes that have been achieved and the level of mastery of students towards knowledge and skills that are known.

3) Select methods, media and materials (choose methods, media, and materials)

The next step is to choose the method, media and teaching material to be used. These three components play an important role in helping students achieve the learning goals outlined. In this step, the teacher will build a bridge between students and the purpose of a systematic plan to use methods, media and materials.

a. The learning method used must be appropriate to meet the objectives for students, who are superior to others or provide all the needs in learning.

b. The media/material used must be suitable with the chosen learning method, objectives, and in accordance with the needs of students.

c. The material provided for students with those needed in mastering learning objectives must be adjusted to the needs of students or the place of learning and equipment.

The selection of methods, media and appropriate teaching materials will be able to optimize student learning outcomes and help students achieve competencies or learning objectives. In choosing existing methods, media and teaching materials, modifying existing teaching materials and producing new teaching materials are needed to be able to use the selected methods, media and teaching materials.

4) Utilize Materials (Utilizing Media And Material)

The next step is to use all three in learning activities. Before using methods, media, and teaching materials, the instructor or designer first needs to conduct a trial run to ensure that the three components can function effectively for use in real situations. Then prepare the classes and supporting facilities needed to be able to use the selected methods, media and teaching materials. 5) Requires learner participation The learning process requires active student mental involvement with the material and substance being studied.Providing practice is an example of how to involve students' mental activities with the material being studied. Students who are actively involved in learning activities will easily learn the learning material, then the teacher gives feedback in the form of knowledge about learning outcomes and motivates students to achieve higher learning achievements. 6) Evaluate After designing the learning activities, the next step that needs to be done is evaluation. The evaluation phase in this model is done to assess the effectiveness of learning and also student learning outcomes. The evaluation process of all learning components needs to be carried out in order to obtain a complete picture of the quality of a learning program.

Prawiradilaga (2009) explains some of the benefits of the ASSURE design as follows.
1. Simple, relatively easy to implement
2. Because it is simple, it can be developed by the teacher himself.
3. Complete components of teaching and learning activities
4. Students can be involved in the preparation of teaching and learning activities.

2. METHODS

Data retrieval in this study was carried out by providing tests of the ability to understand mathematical concepts before and after learning (pretest and posttest) in the control and experimental classes. Data processing and analysis of mathematical concept comprehension ability is performed using statistical tests to increase the ability to understand mathematical concepts (gain index) of the experimental class and the control class with the help of SPSS software version 20.0.

In this study the normality test was carried out by the Kolmogorov-Smirnov Z test using SPSS software version 20.0 with testing criteria that if the probability value (sig) of Z is greater than α = 0.05, then the null hypothesis is accepted (Trihendradi, 2005).

Table 1. The Table of Test for Normality Ability to Understand Mathematical Concepts

Data	Sig.	Information
Pretest (experimental class)	0,066	Sig $> 0,05$, normally distributed
Pretest (control class)	0,200	Sig $> 0,05$, normally distributed
Posttest (experimental class)	0,052	Sig $> 0,05$, normally distributed
Posttest (control class)	0,058	Sig $> 0,05$, normally distributed

In the table above, it appears that the experimental and control class sig are greater than 0.05, so the null hypothesis is accepted. Thus, it can be concluded that the data of mathematical concept understanding ability of the experimental class and the control class are normally distributed.

Table 2. Test the Normality of the Gain Index for Experiment Class and Control Class

Data	Sig.	Information
N-gain (Experimental Class)	0,200	Sig $> 0,05$, normally distributed
N-gain (Control Class)	0,072	Sig $> 0,05$, normally distributed

In the table above it can be seen that the experimental and control class sig are greater than 0.05, so the null hypothesis is accepted. Thus, it can be concluded that the gain index of the experimental class and the control class are normally distributed.

In this study homogeneity tests were also conducted. Following this, the homogeneity test results on the pretest, posttest and N-gain data.

Table 3. Homogeneity Test of Pretest, Posttest, and Gain Index Data

Data	Research Group	Statistik levene	Sig
Pretest	Experimental	0,642	0,426
	Control		
Postetst	Experimental	0,730	0,396
	Control		
N-gain	Experimental	0,120	0,730
	Control		

In the table above, it appears that the pretest data has a sig value greater than 0.05 so that the null hypothesis is accepted. Thus, the pretest data has a homogeneous or equal variance. Posttest data has a sig value greater than 0.05 so that the null hypothesis is accepted. Thus, the posttest data has a homogeneous or equal variance. The gain index has a sig value greater than 0.05 so the null hypothesis is accepted.Thus, the gain index has a homogeneous or equal variance.

3. RESULTS AND DISCUSSION

3.1. Results of Development of Problem Solving Learning Model Oriented Ability to Understanding Mathematical Concepts

The development of problem solving learning models developed is by developing each of its stages. The stages include the stage of understanding the problem, making a problem solving plan, implementing the problem solving plan, and reviewing it. Each stage is developed by incorporating an indicator of the ability to understand mathematical concepts in it. This is so that the learning model developed can improve the ability to understand mathematical concepts.

The first stage is the stage of understanding the problem. At this stage, the teacher asks students to identify the problem presented at the worksheet. The teacher invites students to build their own knowledge by looking at what is known from the existing problems, and also what is asked. When students are looking for things that

are known and asked, the teacher assures students to be able to write what is obtained. Next, the teacher asks several students to express their opinions. Then, the teacher gives an opportunity to students who want to volunteer in expressing their opinions. After that, the teacher invites students to think about what material concepts are related to the problem being faced. The teacher does not limit the concept of related material to be from mathematics, but may be from other subjects. This is used so students have broad thinking to get ideas in answering. Muslich (2007) states that learning characterized by constructivism emphasizes the building of one's own understanding actively, creatively and productively based on prior knowledge and meaningful learning experiences.

The second stage is the stage of making a problem solving plan. At this stage, the teacher invites students to be able to make problem solving plans. Strategies used by students during the learning process are required that relate to concepts already stated in the first stage. The plan can be like using the formula of the material concept used. In addition, students also classify objects based on whether or not the requirements to form the concept are met. The trick is to think about a statement that has been grouped into what is known and asked. This is done to make it easier for students to solve problems.

The third stage is the stage of implementing the problem solving plan. At this stage, the teacher incorporates the third and fourth indicators of the ability to understand mathematical concepts. In implementing the problem solving plan, the teacher invites students to present concepts in various forms of mathematical representation, namely by presenting problems given in the form of tables, graphs, diagrams, sketches, mathematical models or other ways. In addition, students are invited to apply their strategies into calculations. In this stage, students are encouraged to be able to solve their problems so students can get the right answers. Therefore, the stages in the problem solving learning model help students in solving problems let alone the model is also developed. This is in accordance with the statement sanjaya problem solving learning models provide opportunities for students to explore collecting and analyzing data in full to solve the problems encountered. The aim to be achieved is the ability of students to think critically, analytically, systematically, and logically to find alternative solutions to problems through empirically exploring data in growing scientific attitudes.

The last stage is the stage of revisiting. At this stage, students present their answers in front of the class so students have the courage to express their opinions. In addition, at this stage also added the first indicator of understanding the ability of mathematical concepts, namely restating the concepts that have been learned. Thus, students not only present their answers in front of the class, but students can also express the concepts they have learned. This is done so that more students in terms of stabilization will understand mathematical concepts and also so that students are not just memorizing but can understand mathematics correctly. The action was taken so that the purpose of mathematics education in the Depdikbud (2016) "mathematics education in schools is expected to contribute to students being able to understand concepts and apply mathematical procedures in everyday life" and the statement of Chent and Wang (2016) "objectives from mathematics education is to have students who truly understand mathematical concepts rather than just memorizing "can be achieved. Thus, the ability to understand mathematical concepts is very necessary in the process of learning mathematics in schools.

3.2. The Analysis Results of Ability To Understand Mathematical Concepts

Based on the hypothesis test, it was found that the problem solving learning model developed proved to be effectively used in improving the ability to understand mathematical concepts. Increased ability to understand mathematical concepts occur after implementing problem solving learning which is facilitated by a valid, practical, and effective worksheet. This is because the worksheet used is a problem solving learning worksheet where the contents in it adjust to the problem solving learning steps that have been developed. In addition, in the learning process students are invited to be able to analyze their own problems so that students can understand the concept and can connect with other concepts. This in-depth concept planting makes learning mathematics more meaningful in students' memories. This is in accordance with the theory of constructivism (Hamzah, 2008) that educators do not merely provide knowledge to students. Students must build their own knowledge in their minds so that learning mathematics is more meaningful.

The following are the results of the pretest, posttest and N-gain t tests.

Table 4. T-Test On The Pretest

Data	t-Test	Df	Sig	Information
Pretest	1,416	64	0,161	*Sig.(2-tailed)*> 0,05

Based on the table above can be seen the value of Sig. (2-tailed) = 0.161> 0.05, it can be concluded, Ho is accepted. This means that there is no significant difference in the average pretest score between the ability to understand mathematical concepts that follow problem solving learning and the ability to understand mathematical concepts that follow conventional learning. It can be concluded that the initial abilities of the two classes do not differ much or are equivalent.

Table 5. T-Test On The Posttest

Data	t-Test	Df	Sig	Information
Posttest	3,183	64	0,002	*Sig.(2-tailed)* < 0,05

The pretest and posttest score scores of the two classes were analyzed using the t test, to find out whether there were significant differences in the average pretest and posttest scores of students' understanding of mathematical concepts ability to take part in learning problem solving and mathematical problem solving abilities of students who took conventional learning. The conclusion of the study is stated at the 5% significance level.

Table 6. t-test on the *N-gain*

Data	t-Test	Df	Sig	Information
N-gain	3,183	64	0,002	*Sig.(2-tailed)* < 0,05

Based on the table above, it can be seen that the t test analysis of the pretest and posttest scores in the control class, obtained Sig. (2-tailed) = 0.034 < 0.05. Then it can be concluded, H0 is rejected and H1 is accepted. This means that there are significant differences in the average pretest and posttest scores of students' understanding of mathematical concepts ability to follow problem solving learning.

4. CONCLUSION

Based on the result and discussion, the following conclusions are obtained.

1. Development of problem solving learning models to improve the ability to understand mathematical concepts in algebraic function derived material, beginning with a preliminary study that shows the need for developing problem solving learning facilitated by worksheet. Validation results show that the syllabus and lesson plan are appropriate and included in the very good category, as well as the results of the worksheet trial show that the worksheet is included in the very good category. The final result of this development research is the development of problem solving learning models oriented towards the ability to understand mathematical concepts facilitated by worksheet to obtain valid, practical, and effective results.

2. The results of the development of problem solving learning models oriented towards the ability to understand mathematical concepts produce learning models that are more effective than conventional learning models. This can be seen from the activeness of students during the learning process, and also every stage in the problem solving learning model that is developed always facilitates indicators of understanding mathematical concepts.

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