

# Development of Problem Based Learning Method To Increase Students' Mathematical Problem Solving Ability at Numbers Theory Courses

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## ABSTRACT

This article presents development research result of problem based learning method to increase students' mathematical problem solving ability conducted at 4th semester students in 2016 academic years at numbers theory course. The aim of the research is to describe development process of problem based learning method corresponding theoretical concepts to increase mathematical problem solving ability with learning device includes: (a) RPS and (b) learning media which be able to be applied in mathematical learning process and testing learning method which has been developed. This research uses mixed method, qualitative method reviews and describes implementation process of learning method, while quantitative method uses experimental design (pretest and posttest) to discover its effects towards students whether learning method which developed proven effective to increase students' problem solving ability. Based on the results of research and discussion, the study concluded that the strategy of mathematics which has been developed and tested can improve the ability of solving mathematical problems very well (excellent).

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## 1. INTRODUCTION

As we know that mathematic is axiomatic, abstract, formal, and deductive. Therefore, it is reasonable if mathematic belongs to one of science branches considered difficult by students to learn mainly at a course needing analysis and problem solving. Lecturing is an effort to teach students to have ability in developing their ability optimally. Developing which oriented in lecturing is developing of reasoning thinking ability, and how students can solve the problem faced in daily life. Lecturing nowadays is more oriented to students being active to involve in learning process, so they will get experience which be able to develop their thinking ability well.

Hidayati (2016;58) Problem based learning approach designed to assist students in the learning process of mathematics. Problem based learning approach utilizes real context of learning so as to make the students better appreciate the usefulness of mathematics dikehidupan day - her day, and familiarize students in solving complex problems that require higher-level thinking processes of students

Soekisno (2015;118) The process of searching for solutions of problems is surely not a simple reasoning process. It needs higher level of reasoning. The ability to collect information and data, to express arguments, to determine supporting theories, to decide the pathway of problem solving process, have become part of reasoning process that make students possible to solve the problems.

Problem solving is learning to get skill or ability in solving problems logically and rationally. Its purpose is to gain a cognitive

ability to solve the problem completely. Mathematical problems solving needs strategy to do. Truth, accuracy, strength, and speed are needed to solve the problem. Students' skill in arranging strategy is a skill that must be seen by a lecturer, and correct answer is not absolute measurement standard, but the process is more important, where and how the students can get an answer and solve those given problems.

In order to solve mathematical problem is needed to know that at first, mathematical process done and produced by mathematicians is inductive process or reasoning from previous specific cases which developed into general statement. Besides, there is also a process of mathematical knowledge formalization which firstly determines base character (axiom) and base understanding which will be a foundation of next mathematical knowledge must be proven deductively. However, based on the research conducted, researcher still found students who were less understanding on how mathematic happened and how to solve the mathematical problem well based on the needed analysis. Therefore, it is needed a renewable learning method, namely Problem Based Learning method. But, it is not enough if only using that method, it must be developed, so lecturing conducted can ask for students to be active, think critical, be creative then be able to solve mathematical problems well.

Problem based learning is one of learning methods used by giving problems to students in order to solve logically and rationally involving way of thinking process and intellectualism so that the problems can be solved properly and carefully. Problem solving

ability is a high level in learning because it allows students to think critically, creatively, extensively in solving mathematical problem.

Problem based learning is a learning method which encourages students to know way of learnin and be cooperative in a group to find out the solution of problems in real life. Simulation of problem is used to activate students' curiosity before starting to learn a subject. This method prepares students to think critically and analytically, and be able to get and use learning sources properly. So that it can be said that problem based learning is a process of learning which its starting point based on problems in real life, then the students are encouraged to learn those problems based on their prior knowledge and experience, with the result that those ones are formed new knowledge and experience. Discussion using small group is a main point in implementing problem based learning method. This method is a learning process where a problem is a main guide towards that learning. Thus, problem used as a means for students to learn something that support their knowledge.

According to Kamdi (2007:77), "*Problem-Based Learning* is a model in which students engage in trying to solve problems through several stages of the scientific method so that students are expected to be able to solve problems and have skills in solving problems.

Problem based learning method is generally known by having six characteristics: (1) learning pocess started by giving a problem. (2) the problem presented relates to real life or daily activity. (3) organizing discussion around problem. (4) students given a maximum responsibility in forming and running learning process directly. (5) students formed into several small groups. (6) students asked for presenting products or works that they have learned.

This research aims generally to develop problem based learning method which has implication towards increasing of critical and creative thinking skill and solving mathematical problem. Specifically, this research has aim as follows:

- a. To develop method of mathematical learning which is suitable with theoretical concepts to increase mathematical problem solving by learning devices namely (a) Syllabus and Lesson Plan; (b) learning media which can be applied in mathematical learning process and to test learning strategy which has developed by using experimental design (pretest and posttest) to investigate the impact towards students.
- b. To investigate whether learning method which developed proven effective to increase critical and creative thinking skill and mathematical problem solving of students.

## 2. LITERATURE REVIEW

### 2.1. Theoretical Framework

#### Problem Based Learning

*Problem-Based Learning* is a learning strategy that has purpose to introduce students towards problems or cases relating to learning materials which is studying. In such this learning, students asked for doing learning activity leading to problem solving presented by lecturer.

Problem-Based Learning is a learning method that has characteristic by existence of real problem as contexts for students to think critically, have problem solving skill and to get knowledge.

Sahrudin (2013:11) say that *Problem-Based Learning* is development of curriculum and learning system which develop simultaneously problem solving strategy and knowledge bases and skills by placing students in active role as daily problems solver that

unstructured well. Two those definitions have meaning that PBL or PBM is each learning condition led by a daily problem.

Saptono (2003), "Problem Based Learning is a way of constructing and teaching course using problem as a stimulus and focus on student activity." Then, H.S. Barrows (1982), an expert of *Problem-Based Learnings* says that *Problem-Based Learning* is a learning method based on principle that problem can be used as starting point to get and integrate a new knowledge

Referring to experts' opinions, it can be concluded that Problem-Based Learning is a learning method which encourage students to know learning way and be cooperative in group to find out problems solution in real life. Simulation of problem used to activate students' curiosity before starting to learn a subject. Problem-Based Learning prepares students to think critically and analytically then be able to get and use learning sources properly. In short.

PBL is learning process that has learning starting point based on the real life problems, then students encouraged to learn problems based on their prior knowledge and experience, so that, it will be formed new knowledge and experience. Discussion by using small group is main point in implementing PBL. PBL is a learning process where a problem as a main guide leading that learning. Therefore, the problem used as mean, so students can learn something which support their knowledge.

Learning strategy of Problem Based Learning is generally known as follows:

1. Leraning activity is started by giving problem.
2. Problem which presented relates to real life or daily activity
3. Organizing discussion around problem.
4. Students given a maximum responsibility in forming and running learning process directly.
5. Students formed into several small groups.
6. Students asked for presenting products or works that they have learned.

## 3. METHOD

Development research is a research designed to produce a product and a new procedure which conducted systematically in field test, evaluation, and to filter till finding a specific, efficient, quality criteria. This research aims to develop existing learning method namely Problem Based Learning in developing students' mathematical problem solving ability at Numbers Theory course to be better than before.

This research used mixed method, qualitative method reviewed and described process of developing and implementing of problem based learning method at learning mathematic especially at Numbers Theory course. Too, qualitative method answered research questions based on results of interviews and observation and analysed qualitatively by desribing findings at the field. Meanwhile, quantitative method used experimental design (pretest and posttest) to investigate the impact towards students if learning strategy which developed proven effective to increase students' mathematical ability of critical and creative thinking and problem solving. Qualitative research started by developing inovative learning device at S1 students of Mathematics Education to empower mathematical problem solving ability consisting of Syllabus, Lesson Plan and Assesment Sheet of Numbers Theory course. Here is the research objects:

**Tabel 1. Objects of the Research**

Group	Study Program/University	Class	Total
Small group (first test)	Mathematics Education, Faculty of Teacher Training and Education Science, University of Mathla'ul Anwar Banten	IV B	13
Big group (second test)	Mathematics Education, Faculty of Teacher Training and Education Science, University of Mathla'ul Anwar Banten	IV C	18

In this developing research generally consisted of qualitative analysis from the start till the end, namely developing, implementing and evaluating. From those 5 steps could be made into 10 steps of learning strategy by adopting Dick, Carey, & Carey model (2001:2-3), those steps arranged as follows: (1) identifying the purpose of learning; (2) conducting instructional analysis; (3) identifying behavior, input, and characteristic of students; (4) formulating the purpose of implementation; (5) developing learning instrument; (6) developing learning strategy; (7) developing and selecting learning materials; (8) designing and conducting formative

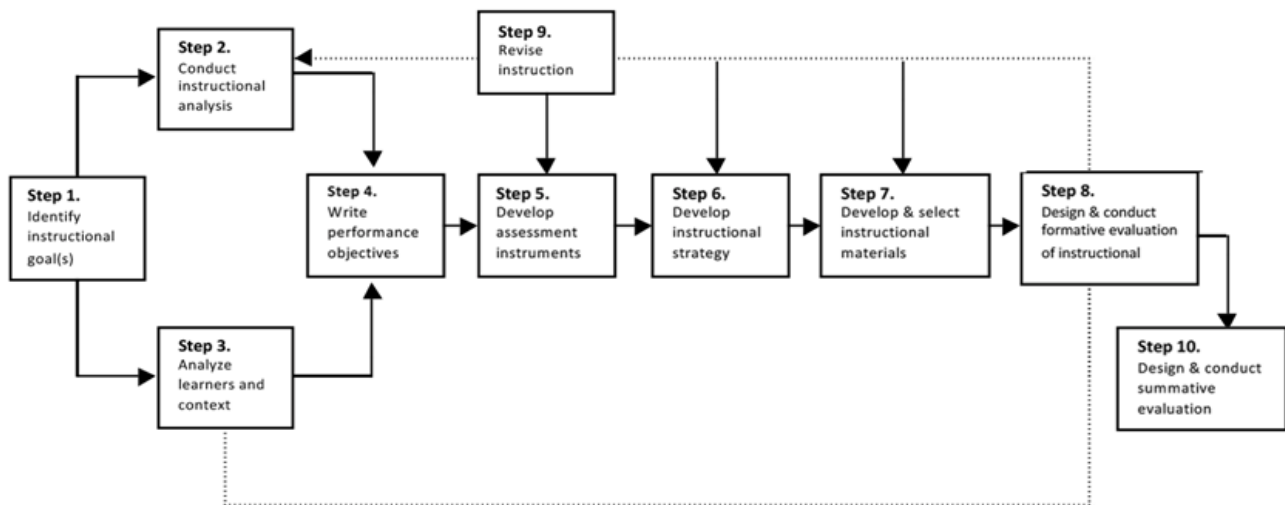
evaluation; (9) revising learning material; and (10) designing and conducting summative evaluation.

If those 10 steps of developing conducted well then research error will be small because those steps included good learning processes.

Here is the plot of developing steps:

**Tabel 2. Object of the Research**

Group	Study Program/University	Class	Total
Small group (first step)	Mathematics Education, Faculty of Teacher Training and Education Science, University of Mathla'ul Anwar Banten	IV B	13
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**Figure 1. Step development model of Dick, Carey & Carey**

### 3. RESULT AND DISCUSSION

#### 3.1 Learning Method Development Process

In conducting the development of teaching methods problem based learning researchers developed innovative teaching methods, in the process, the researchers tested the first stage in small groups to carry out learning for 4 weeks and tested on a large group within the same timeframe.

#### 3.2 The First Phase of Trial

In the first stage of trials conducted in the IV Semester Class B amounts to 13 students. All students in this class is based on the results of interviews conducted by the researchers during the learning process well after learning or prior learning. During the four month periode i got a very good impression, the students in class B feel happy and feel challenged by the process of learning that puts students to think critically, creatively and can solve the problem. Students becomes challenged when treated mature and responsible with the tasks given by the lecturer. During the learning process not only the lecturer asked the students to resolve the

problem, but also invites students to be able to understand why and how to do it and implement it in their daily lives. In the Formative Class Evaluation (FCE) it can be seen that each meeting the students showed improvements in learning good attitudes or individual self-study or cooperation or groups.

**Table 3. FCE First Phase Trial Results**

Student	Component	The first week	The second week	The third week	The fourth week
Semester IV Grades B	Result	2.75	2.78	2.89	2.90
	Will	2.80	2.83	2.85	2.89
	Strategy	2.45	2.59	2.65	2.75
	Cooperation	2.70	2.75	2.80	2.90
	Average	2.67	2.73	2.79	2.86
	Criteria	Good	Good	Very Good	Very Good

Based on the results table FCE in general it can be concluded that every week there are changes in the willingness of students, it can be seen that there is an increase in yield, will, and cooperation methods in which students in the learning process. But in the first

phase of this pilot phase may be some improvement in the learning process, among other strategies used is still considered weak to improve students' ability in solving mathematical problems well.

In the first stage also quantitative analysis and calculate how exaggerated the increase that occurred between the pre-test and post-test were applied to students in the first phase. From the pre-test and post-test are presented below:

**Table 4.** Mathematical Problem Solving Ability The First Phase of Trial

Statistics	Pre-test	Post-test	N-gain
$\bar{x}$	3.14	18.21	0.74
SD	4.13	5.19	0.23
%	13.08 %	75.87%	

From the pre-test and post-test obtained figure mathematical problem solving ability of students before and after the implementation of innovative learning strategies. Before the implementation of the learning method of problem-based learning is more innovative capabilities menyelesaikan mathematical problem of students is very low, only 13% the ability of the standard maximum ability value predefined by researchers, but the value to be high when the post-test carried out until the ability of solving mathematical problem 75.87% of students reaching this menunjukkan that an increase in mathematical problem solving ability of students in the first phase of trials with n-gain of 0.74 entering the high category.

Seeing the first trial phase are still many shortcomings then do an evaluation to proceed to the second stage in a different class. With a record of the first trial phase have been revised to better the current implementation of the second stage with a number of students more. Revision emphasis in the use of strategies for getting satisfaction is very less, the researchers berinovasi further how to develop strategies for learning math better in improving the ability of solving mathematical problem student, in addition to revising the strategy of innovative learning and to enhance the students using the approach of scientific 5M ie observe, to question, to reason, to try and establish networks and to guide students in finding out not what he was doing with the record bukan notify students. It also emphasizes the ability to speak as a communication tool carrier of knowledge, and logical thinking, critical, creative and systematic.

### 3.3 The Second Phase of Trial

In the second phase trial conducted in the fourth semester of class C with a number of students as many as 18 students were more than testing the first stage. In the formative Class Evaluation (FCE) it can be seen that each meeting the students showed improvements in learning good attitudes or individual self-study or cooperation or groups.

**Tabel 5.** FCE Second Phase Trial Results

Student	Component	The first week	The second week	The third week	the fourth week
Semester IV	Result	2.9	2.9	2.89	2.9
	Will	2.8	2.83	2.85	2.89
	Strategy	2.8	2.83	2.9	2.95
	Cooperation	2.85	2.85	2.9	2.95
	Average	2.83	2.85	2.9	2.9
	Criteria	Very good	Very good	Very good	Very good

From the results of the second phase of FCE components which have a higher value than the first phase trial., yield components have excellent value each week, well the first week, the second but has decreased in the third week but resumed higher at week four this showed that the learning strategies developed better to use. In the second component is the willingness to learn the students also showed a good value at all at the meeting the first week of the meeting students had lower scores than the results in the fourth week but the value given shows that the willingness of students is large enough to learn to use learning methods that are being developed.

In the third component showed improvement after the revision on learning strategies in the trial of the first stage, meaning that revisions made in the first phase was considered successful because at trial the second stage of the first meeting until the end showed an increase in good increase which indicates that the strategy is being developed more and better than ever, the average all components also showed excellent results with quality and it can be concluded that the development of learning strategies to improve mathematical problem solving ability of students considered successful.

In the second phase trial also measured the pre-test and post-test with the following results.

**Table 6.** He Ability Of Solving Mathematical Problems. The Second Phase Of Trial

Data Statistik	Pre-test	Post-test	N-gain
$\bar{x}$	3.79	20.43	0.84
SD	3.91	3.72	0.17
%	15.79 %	85.12%	

From the pre-test and post-test obtained picture mathematical problem solving ability of students before and after the implementation of innovative learning strategies. Before the implementation of the strategy of innovative learning ability complete mathematical problem of students is very low, reaching only 15.79% capability of the standard maximum, but that value is high when the post-test carried out until the ability of solving mathematical problem of students reaching 85.12%, this shows that there is an increased problem-solving ability mathematically students in the first phase of trials with n-gain of 0.84 entering the high category.

## 4. CONCLUSION

Based on the results of research and discussion, the study concluded that the strategy of mathematics which has been developed and tested can improve the ability of solving mathematical problems very well (excellent) but in the process of development of teaching methods of mathematics, there are several things that must be considered, namely the test learning strategies developed must always be revised if there are things that do not support students to master some of the components that have been defined, such as the trial of the first phase of the study has weaknesses in teaching methods developed so that the students found the development of methods that do less well understood student which in the end led to student difficulty in grasping the intent and direction that tries to explain by lecturers.

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