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**The Effect of Problem Based Learning, Discovery Learning, and Open Ended Models to Mathematical Problem Solving Ability of SMP Negeri 1 Percut Sei Tuan**

**1 Dian Fitria Tanjung, 2Edi Syahputra, 3Irvan**

1 Mahasiswa Magister Pendidikan Matematika Program Pascsarjana Universitas Muhammadiyah Sumatera Utara,

2 Universitas Negeri Medan, 3Universitas Muhammadiyah Sumatera Utara, Indonesia

1 dyanfitrya612@gmail.com 2edisyahputra01.es@gmail.com 3irvan@umsu.ac.id

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| **INFO ARTIKEL** | **ABSTRAK** |
| **Riwayat Artikel:** Diterima : --  Disetujui : -- | **Abstract**: This research is to look at the effect of problem based learning, discovery learning, and open ended models on the mathematical problem solving abilities of students. The type of research is a quasi experiment with a three treatment counter balanced design research design. The instruments used: (1) students 'initial mathematical ability tests, (2) tests of students' mathematical problem solving abilities with the Phytagorean Theorem material. Inferential data were performed using covariance analysis (ANACOVA). The samples of this study were classes VIII1 , VIII2 , and VIII 3. The results are: (1) Of the three learning models conducted using the model of problem based learning, discovery learning, and open ended had a positive effect on the ability to solve mathematical problems. (2) The ability to solve mathematical problems of students taught by problem based learning models is better than the using discovery learning and open ended models . (3) There is an interaction between the initial ability of mathematics and learning models.  **Abstrak*:*** Tujuan dari penelitian ini adalah untuk melihat pengaruh model problem based learning, discovery learning, dan open ended terhadap kemampuan pemecahan masalah matematika siswa. Jenis penelitian ini adalah quasi experiment dengan design penelitian a three treatment counter balanced design. Instrumen yang digunakan: (1) tes awal matematika siswa, (2) tes pemecahan masalah matematika dengan materi Teorema Phytagoras. Data inferensial yang dilakukan dengan menggunakan analisis covarians (ANACOVA). Sampel penelitian ini adalah kelas VIII1, VIII2, danVIII3 dipilih dengan purposive sampling. Hasil penelitian menunjukkan bahwa: (1) Dari ketiga model pembelajaran yang dilakukan dengan menggunakan model problem based learning, discovery learning, dan open ended memiliki pengaruh positif terhadap kemampuan pemecahan masalah matematika. (2) Kemampuan pemecahan masalah matematika siswa yang diajar dengan menggunakan model problem based learning lebih baik dibandingkan dengan kemampuan pemecahan masalah matematika yang diajar dengan menggunakan model discovery learning dan open ended. (3) Terdapat interaksi antara kemampuan awal matematika dan model pembelajaran yang berlangsung terhadap kemampuan pemecahan masalah matematika siswa. |
| ***Keywords*:**  *Problem based learning*  *Discovery learning*  *Open ended*  *Mathematical problem*  *solving ability*.  **Kata Kunci:**  *Problem based learning*  *Discovery learning*  *Open ended*  Pemecahan masalah |
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1. **BACKGROUND**

The initial step of students' preparation in following the learning process is that students must have initial abilities . Initial abilities are obtained based on prior knowledge . The initial ability illustrates the readiness of students to receive lessons delivered by the teacher , to find out how far students master the subject matter. So with this initial ability the teacher can design learning better.

In learning in school, mathematics is a lesson that can train students to think logically, solve a problem in real life, be able to think critically and creatively. Therefore, mathematics lessons need to be mastered and studied by students. Besides mathematics needs to be mastered and studied, students must also have some abilities. Based on the type Hendriana & Soemarmo (2014) suggested that Mathematical abilities are classified into five main competencies, namely : mathematical understanding , mathematical problem solving , mathematical communication , mathematical connection , and mathematical reasoning . Problem Solving will be examined in this regard.

Problem solving abilities pay attention to understanding problems, the importance of students learning problem solving, steps and problem solving strategies. Then students must be know, understand, and can apply the process of problem solving mathematics itself. The ability to solve mathematical problems is also an important component in the process of learning mathematics that supports students' mathematical activities, so the ability of problem solving among students needs attention in learning.

The 2014 Puspendik Team said, " students ' difficulty in solving non-routine problem solving problems is caused by the attachment of Indonesian students to the ready-made formula as a product". This means that the mathematics learning process carried out in class only emphasizes memorizing the ready-made formula and has not facilitated students to be able to solve a given problem . In fact, in the initial research at SMP Negeri 1 Percut Sei Tuan the level of students' initial mathematical abilities was still in the medium and low categories. It is seen that students still experience problems when solving problems. From the students' answer process, the problem solving that was done was still not optimal and still not quite right students need better mathematical problem solving skills . In this material students are still fixated on the sample questions given, whereas in the 2013 curriculum students are required to be more creative in problem solving, so that learning activities still do not fully meet expectations in accordance with learning objectives. So it needs to be seen what factors make the problem-solving ability is not optimal.

In the learning process also requires a learning model that can make students better at solving mathematical problems . One alternative used should be a student-centered learning model , and can facilitate students learning to solve the given problem . Some of the learning models that want to be used in this case are problem based learning (PBL) , discovery learning (DL) and open ended (OE) models.

Problem-based learning is a learning model that is designed to use problems in real life and emphasizes the use of problems as a means for students to develop critical and creative thinking skills in solving real problems (Retnawati & Susanto, 2016). Problem based learning is a learning model that provides authentic experiences that encourage students to learn actively, construct knowledge, and

integrate the context of school learning and learning in real life naturally (Abidin, 2014). In problem based learning , it is the one who is raised who needs it Authentic investigative investigation skills and higher-order thinking skills can be developed. New knowledge and experience gained by using previous knowledge and experience. So, the problem is there used as a means for students to learn something that can support science ( Nurullita, Surya & Syahputra, 2017) .

In problem based learning it is emphasized that learning begins with the presentation of the problem. Therefore, problem-based learning begins with solving a problem, and the problem posed to students must be able to provide new information or ideas so that students gain new knowledge before they can solve the problem.

Decellation learning is a learning model that changes teacher - centered learning be student- centered learning (Damanik and Syahputra, 2018).  Discovery learning is a learning model to develop active student learning by discovering on their own, investigating on their own, so the results obtained will last long in memory, students will not be easily forgotten (Wicaksana, Mardiyana & Usodo, 2016). Decellation learning is a learning model that can stimulate students' ability to think creatively, analytically, systematically, and logically to find alternative problem solving by exploring data to foster scientific attitudes (Nahdi, 2018). So that discovery learning is a learning model that changes learning ranging from teacher-centered to student-centered learning so that students learn actively by finding themselves, investigating themselves and growing scientific attitudes in accordance with the stages of discovery learning, namely: 1) Stimulation , 2) Problem statement , 3) Data collection  4) Data processing , 5) Pproof, 6) Generalization (drawing conclusions).

According to Shimada & Becker in Gordah & Syarifah (2012) open ended is a learning approach that starts from introducing students on open problems. Learning continues by using many correct answers to the problems given to provide experience to students in finding something new in the learning process. Open ended learning is a way of presenting teaching material through issues raised openly and contextually so as to form a mindset, cohesiveness, openness and variety of thinking (Istarani, 2015). Meanwhile according to Hannafin in Huda (2014) stated that the approach open ended is a learning process in which individual / student goals and desires are built and achieved openly, not only open ended goals can also refer to ways to achieve the learning goals themselves. According to Nohda in Firdaus, As'ari & Qohar (2016) the purpose of the open ended approach is to help develop students' creative activities and mathematical thinking patterns through simultaneous problem solving . In other words, students 'creative activities and mathematical thought patterns must be developed to the maximum extent possible in accordance with students' abilities.

So the open ended approach is a learning approach that begins by presenting teaching material through the problems raised openly and contextually so as to form a mindset in accordance with the steps, namely: 1) Facing students to open problems and how students arrive at a solution. 2) Guiding students to solve the problem yourself. 3) Letting students solve problems with various solutions and diverse answers. 4) Asking students to present their findings.

Based on the description , the writer is interested in conducting research entitled " The Effect of Problem Based Learning, Discovery Learning, and Open Ended Models Against the Mathematical Problem Solving Ability of Students in SMP Negeri 1 Percut Sei Tuan"

# B. RESEARCH METHODS

## Types of research

This research is quantitative, using the quasi experiment. The purpose of this study is a three counter balanced design design that was implemented at SMP Negeri 1 Percut Sei Tuan, 2017/2018 school year. The sample of this research is class VIII 1 , VIII 2 and VIII 3 .

**2. Research Population**

The population of this research are students of class VIII, amounting to 299 students who were divided into 9 study group. The sampling technique in this study was conducted with a purposive sampling technique. Purposive sampling technique according to Sugiyono (2012) is a sampling technique with certain considerations. In this study was taken based on an agreement between the school and the researcher. This was done so as not to interfere with much activity in school.

**3. Data collection technique**

Data collection techniques in this study is to use tests and non-tests to measure the initial ability of mathematics and the final test to measure the ability to solve mathematical problems . Data obtained through tests are used to see the effect of problem and discovery learning.

**4. Data analysis**

For the first data analysis using descriptive analysis. The data described is data obtained from measurements on variables research variable (dependent variable). The research data analyzed were the initial mathematical ability and posttest data on aspects of mathematical problem solving ability .

The second data analysis is by using inferential analysis which consists of: normality test, homogeneity test and hypothesis test using ANACOVA. The data to be analyzed in this study are the initial ability as a accompanying variable and the results of the post test (final ability) as the dependent variable. The use of ANACOVA is caused in this study using accompanying variables as independent variables that are difficult to control but can be measured together with the dependent variable. Mathematical models for analysis of covariance are expressed as follows (Syahputra, 2016 )

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# C. RESULTS AND DISCUSSIONS

**1.** **Description of the results of tests of early mathematical abilities and the ability to solve mathematical problems**

The analysis of mathematical problem solving abilities is carried out twice, namely at the beginning of learning to see students 'initial mathematical abilities and final tests to see students' mathematical problem solving abilities. So for this purpose, researchers used questions that were adapted from elementary school National Exam questions. The question consisted of 35 multiple choice questions.

To get a picture of students' initial mathematical abilities, the mean and standard deviation is calculated. The complete calculation results can be seen in the appendix, while the summary results are :

**Table 1** Early Mathematics Ability 3 models

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Min | Max | The mean | Std. Deviation |
| KAM-PBL | 32 | 79.00 | 91.00 | 83,31 | 2.96689 |
| KAM-DL | 32 | 78.00 | 91.00 | 82.81 | 3,20722 |
| KAM-OE | 32 | 78.00 | 90.00 | 82.43 | 2.85044 |
| Valid N (listwise) | 32 |  |  |  |  |

From table 1 it can be seen that the initial mathematical ability of students with moderate criteria is more dominant than the initial mathematical ability with high criteria and the initial mathematical ability with low criteria.

At the second meeting after the students' initial mathematics proficiency tests, the three experimental classes used data MID value semester 1 first before learning is carried out in each experimental class . At the last meeting, each experimental class was given a test to look back abilities after the learning process was carried out, whether or not there was an improvement that can be seen in table 2 below:

**Table** **2** Data on Test Results for Students' Mathematical Problem Solving Abilities Using Problem Based Learning , Descovery Learning and Open Ended

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Min | Max | The mean | Std. Deviation |
| KPM-PBL | 32 | 37.00 | 39.00 | 37.28 | , 52267 |
| KPM-DL | 32 | 33.00 | 38.00 | 35.46 | 1.2439 |
| KPM-OE | 32 | 29.00 | 34.00 | 31.75 | 1.3678 |
| Valid N (listwise) | 32 |  |  |  |  |

It can be seen that the comparison of the scores of the three experimental classes, the lowest value is in the open ended model and the highest value is the problem based learning model .

**2. ANACOVA model of** **problem based learning, discovery** **learning** **and** **open ended** **to problem solving abilities**

Furthermore, testing the hypothesis that will be tested using ANACOVA include :

1) Statistical Hypothesis :

0 Nothing influence of PBL on    students' skill in mathematical problem solving

There is an effect of PBL on students' mathematical problem solving.

Information : average mathematical problem-solving ability given 3 learning models

The results of hypothesis testing assisted by SPSS version 23 can be seen in the following table 3.

**Table 3** Results Hypothesis Testing PBL Model Against the Problem Solving Ability

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| DependentVariable: KPM1 | | | | | |
| Source | Type III Sumof Squares | df | Mean Square | F | Sig. |
| Prototype | 1148,893 a | 12 | 95,741 | 2,321 | , 049 |
| Cut of | 164541,542 | 1 | 164541,542 | 3989,018 | , 000 |
| PBL | 1148,893 | 12 | 95,741 | 2,321 | , 049 |
| Error | 783,724 | 19 | 41,249 |  |  |
| Total | 255315,625 | 32 |  |  |  |
| Total of correct | 1932,617 | 31 |  |  |  |
| a. R Squared =, 594 (Adjusted R Squared =, 338) | | | | | |

2) Statistical Hypothesis :

No one effect of discovery learning on students' mathematical problem solving skills

Having effect of discovery learning towards mathematical problem solving skills

Information : average mathematical problem-solving ability given 3 learning models

Hypothesis test results seen in table 4 below:

**Table 4** Results Hypothesis Testing of Discovery Learning Model Against Problem Solving Ability

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dependentv ariable: KPM2 | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 170,219 a | 9 | 18,913 | 3,715 | , 006 |
| Intercept | 138045,037 | 1 | 138045,037 | 27115,989 | , 000 |
| DL | 180,219 | 10 | 18,713 | 3,815 | , 006 |
| Error | 112,000 | 21 | 5,101 |  |  |
| Total | 221561,000 | 32 |  |  |  |
| Corrected Total | 282,219 | 31 |  |  |  |
| a. R Squared = , 603 (Adjusted R Squared = , 441) | | | | | |

3) Statistical Hypothesis :

There is no open ended affect on students' mathematical problem solving skills

There is an open ended influence on students' mathematical problem solving skills

Information : average mathematical problem-solving ability given 3 learning models

The results of the hypotesis can be seen in table 5 below:

**Table** **5** Results Hypothesis Testing Open Ended Model Against Problem Solving Ability

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| DependentVariable: KPM3 | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Model of correct | 170,219 a | 9 | 18,913 | 3,715 | , 006 |
| Intercept | 138045,037 | 1 | 138045,037 | 27115,989 | , 000 |
| OE | 170,219 | 9 | 18,913 | 3,715 | , 006 |
| Error | 112,000 | 22 | 5,091 |  |  |
| Total | 221561,000 | 32 |  |  |  |
| Corrected for Total | 282,219 | 31 |  |  |  |
| a. R Squared = , 603 (Adjusted R Squared = , 441) | | | | | |

4) Statistical Hypothesis :

No interaction between abilities and learning models with students' problem solving

There is an interaction between abilities and learning models

Information : average mathematical problem-solving ability given 3 learning models

Hypothesis test results are shown in table 6 below:

**Table 6.** Results Hypothesis Testing Open Ended Model Against Problem Solving Ability

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dependent Variable: KPM | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 1028,705 a | 77 | 13,360 | 382,722 | , 000 |
| Intercept | 1,948 | 1 | 1,948 | 55,794 | , 000 |
| MID | 219,747 | 1 | 219,747 | 6295,144 | , 000 |
| KAM | , 326 | 13 | , 025 | , 717 | , 726 |
| MODEL | 159,063 | 20 | 7,953 | 227,836 | , 000 |
| KAM \* MODEL | 1,550 | 43 | , 036 | 1,032 | , 490 |
| Error | , 628 | 18 | , 035 |  |  |
| Total | 134533,500 | 96 |  |  |  |
| Corrected Total | 1029,333 | 95 |  |  |  |
| a.Squared of R =, 999 (Adjusted R Squared =, 997) | | | | | |

From table 6 it can be seen that the significant number on the variable MID value is 0,000 <0.05, which means  rejected, so that there is a linear relationship between MID with students' mathematical problem solving abilities and assumptions of covariance analysis which require linearity between accompaniment variables  ( covariant ) with dependent variables  has been fulfilled.

Furthermore, to see the cause of  learning  on students' mathematicalproblem solving abilities, by ignoring the effect of the initial mathematical ability of the model it appears that the significance number is 0,000 <0.05 which means  was rejected . Then there is an impact of learning models on students' mathematical problem solving abilities.

The effect of initial mathematical ability and differences in learning models simultaneously, can be seen in the Corrected Model with a significance value of 0,000 <0.05 which means  was rejected . This means that at the 95% level , students 'initial mathematical abilities and differences in the model of problem based learning , discovery learning and open ended simultaneously (simultaneously) affect the ability of students' mathematical problem solving.

# CONCLUTIONS AND SUGGESTIONS

# The conclusions of this study are as follows :

1.   Of the three learning models carried out using the model of problem based learning, discovery learning, and open ended have a positive influence on students' mathematical problem solving abilities.

2.    Ability to solve mathematical problems taught by using problem based learning is better than the ability to solve mathematical discovery learning and open ended.

3.    There is an interaction between the initial ability of mathematics and learning models that take place on the ability to solve students' mathematical problems.

Furthermore, the authors suggest further research that examines early mathematical abilities and variations of other learning models on the ability to solve mathematical problems in other appropriate material and with other aspects such as the ability to think creatively , and the ability to think critically.

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